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Advertisement Index, see page xxviii.

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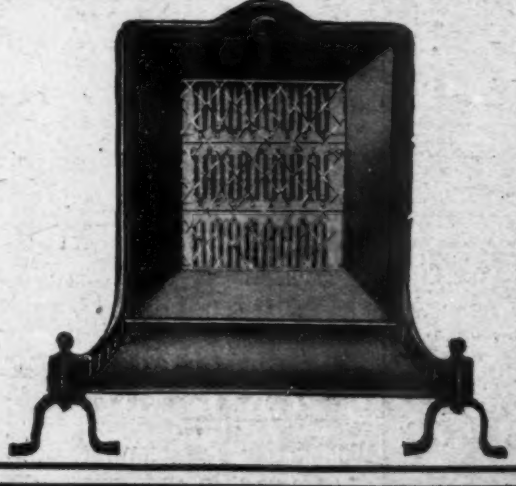

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Vol. LXXXII.] CONTENTS: March 29, 1918. [No. 2,105.

	Page
Institution Proceedings	289
Legislation in Austria	290
Saving Fuel	290
Notes on Electric Locomotives	291
Aluminium in Transformers	292
The British Electrical and Allied Manufacturers' Association (*concluded*)	293
New Electrical Devices, Fittings and Plant (*illus.*)	293
The Mechanical Design and Specification of the Turbo-Alternator Rotor, by S. F. Barclay (*illus.*)	295
American Exports of Electrical Goods	298
Reviews	299
Notes on the Mineral Output of Great Britain	300
Correspondence—	
"Prof. Perry's" Harmonic Analysis	301
Nomenclature	301
The C.T.A.A. and the E.P.E.A.	301
National Electricity Supply	301
War Items	301
Business Notes	302
Notes	304
City Notes	306
Stocks and Shares	307
Market Quotations	308
National Electricity Supply, by "A Power Station Engineer"	309
The Control of Large Amounts of Power, by E. B. Wedmore (*concluded*) (*illus.*)	310
The New Ironclad-Switch Department at Witton (*illus.*)	311
New Patents Applied for, 1918	312
Abstracts of Published Specifications	312
Contractors' Column	Advertisement page xxii

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INSTITUTION PROCEEDINGS.

"THE times are changed"—very radically changed; and it is satisfactory, as well as interesting, to observe how the Institution of Electrical Engineers is changing with them. In days gone by, when Dr. Ferranti was at the helm, and addressed his classic exhortation to the Institution to be up and doing, we thought a change was imminent, but the forces of reaction were too strong, and the impulse was damped out, together with the Industrial Committee, which proved to be too far out of phase with the Council of pre-war days to be other than a wattless component of its working. But now a fresh impulse has been received from the world-war, and circumstances have so far changed that the scheme outlined by Dr. Ferranti, if not within measurable distance of fruition, is at least visible upon the horizon of the electrical world; and the Council of the Institution, cautiously and somewhat gingerly, is feeling its way towards a wider view of its responsibilities and a more effective participation in industrial affairs. No doubt the improvement in its attitude has been largely due to guidance from the presidential chair, and the Institution has been fortunate of late in a succession of energetic and open-minded leaders in that capacity whose influence has been wholly salutary. Its present occupant "made good" at the start, and although Mr. Wordingham in his presidential address seemed somewhat nettled by past criticism of the Council in the electrical Press, he outlined a programme of progress and reform on remarkably similar lines to those which the Press has persistently advocated, and shows every sign of determination to carry it into effect.

Already he has initiated a movement towards the realisation of his long-cherished aim to establish a National Proving House; he has successfully inaugurated, in spite of the difficulties of the times, the informal dinner after the ordinary meeting, which bids fair to become a permanent feature of the proceedings; he has taken steps to improve the discussions at the meetings, and under his *régime* the rules for wiring ships, the prosecution of research, the reform of the Patent Law, and other important matters are being pushed forward.

The forthcoming joint meeting of the Institution with the Electrical Section of the Royal Society of Medicine, accompanied by an exhibition of apparatus, gives ground for hoping that henceforth, by co-operation between the two professions concerned, electromedical appliances, which in the past were mainly imported from Germany, will be manufactured wholly in this country. Our regrettable neglect of this important branch of the industry was pointed out by the late Mr. Duddell in his presidential address in 1912; it was, we believe, largely due to the predilection of the medical profession for foreign-made apparatus, but here, again, the war has effected a welcome change of attitude.

A notable feature of the meetings of late has been the curtailment of the reading of the papers by the authors, who have limited themselves to a brief summary of the contents. We have often urged that the main purpose of the meeting is not to listen to the reading of a paper, which can be read to greater advantage elsewhere, but to discuss the subject dealt with, as fully as possible, and we have pointed out that the American Societies issue their papers, or even publish them in the Press, long before the meetings, to facilitate full discussion. In these times of paper scarcity we can no longer advocate the distribution of copies of the paper broadcast in advance, but members interested can usually obtain them on application to the Secretary, and it seems obvious that the time thus saved at the meeting should result in greatly improved discussions, which would no longer be confined to a few experts. Perhaps Dr. Barclay, at the meeting on Thursday last, carried the new practice to an extreme when he read no part of the paper whatever; but, on the other hand, the address which he gave, with the aid of excellent lantern slides, on the microstructure of steel and the behaviour of that metal under various conditions was of such absorbing interest and so admirably delivered that we feel sure the audience were more than satisfied with the innovation. The Institution is certainly to be congratulated upon the remarkable excellence attained by the majority of the papers of the current session, and upon the progressive spirit which has of late been manifest in its proceedings.

Legislation in Austria.

A Bill has been introduced by the Austrian Government in the Lower Chamber with the object of regulating, among other matters, the establishment and working of electricity supply stations. On the submission of the Bill, the Minister for Labour expressed regret at the country's lack of progress, which is shown by the inadequate utilisation of water power, the lack of system in carrying on the industry, and the preponderance of small stations over the large works. He stated that if the water powers were appropriately used it would be possible not only to economise largely in the consumption of coal, but also to be free from the necessity for importing coal from Germany, and, in fact, more coal could be exported to the latter country. The leading idea of the Bill is to provide a system of electricity administration, and, at the same time, to guarantee the requirements of the State and the general community.

The Bill stipulates that a concession must first be obtained to authorise the delivery of energy to third parties, the concession giving the right of erecting conductors, and being capable of extension so as to confer the right of expropriation. A limitation of areas of supply is fixed in order to ensure systematic methods in the supply of electricity. The State may grant financial assistance to the undertakings in return for the State being given an influence in the management of the business. The promoters of works who apply for facilities in excess of those conferring the right of erecting conductors will be subject to the State participating in the profits and the lapse of the concession after 25 years, when the undertakings will revert to the State, provided that the concessions are not renewed. In these cases the State, after the undertaking has paid 6 per cent. on the ordinary share capital, will receive one-third of the profits up to 10 per cent., and one-half of the profits realised beyond this percentage. The Bill further makes provision for the prevention of any monopoly in the installation contract department.

Saving Fuel.

At the conferences which have been held recently in various centres by the Tramways Committee of the Board of Trade, the subject of economy has naturally assumed considerable prominence, and suggestions have been made for the relief of the tramway services by distributing the traffic at busy hours over a longer period. This has been accomplished to some extent in certain cases, but a good deal remains to be done, and some useful hints may be derived from the report of a committee appointed by the Electric Railway War Board to investigate the possibilities of fuel economy on the tramways of Washington, U.S.A., recently published in the *Electric Railway Journal*. The Committee estimates that an annual saving of no less than 25,790 tons of coal can be effected, whilst actually improving the service to the public. One-third of the saving is ascribed to a reduction in the number of stops, partly by extending the distance between stopping places, and partly by adopting the "skip-stop" plan, according to which alternate cars on a given route miss, say, every other stop—an idea which is already to some extent in vogue on the London Electric Railways. It is estimated that in Washington the number of stopping-places can be reduced by 40 per cent., and the actual stops by 25 per cent., compared with those made at present, without any hardship to the public; there would then be about eight stops per mile, and no-one need walk further than about 400 ft. at most.

Reducing unnecessary mileage in non-rush hours, by running short-stage cars in busy parts, and adopting a longer headway in the outlying districts, offers a possible saving of 3,000 tons of coal. By transferring the traction load to the most economical generating station a further economy is made of nearly 10,000 tons, and, lastly, the plan of "staggering" the office hours of Government departments at 15-minute intervals, over a period of three-quarters of an hour, is expected to bring about a small reduction in fuel consumed, besides reducing the number of cars run during the rush hours and the amount of generating plant required.

A similar investigation was carried out at Rochester, U.S.A., by the New York State Railways; the industrial conditions of the city were studied, and with the hearty co-operation of the local manufacturing firms a schedule of "staggered" opening and closing hours for the various establishments was drawn up, which enabled the use of 20 to 30 cars to be discontinued during the rush hours. This plan has been successfully adopted here also to some extent, and is advocated by the Board of Trade Committee. Drastic curtailment of both tramway and railway accommodation in the near future is foreshadowed by the Government, but evidently there are also other methods of effecting material economies, which should not be overlooked.

In the same issue of our contemporary, particulars are given of the construction of a "super-station" of 200,000-kw. capacity at Windsor, U.S.A., jointly by two companies, with a view to securing the advantages of large generating sets (six of which will be installed), an improved diversity factor, and proximity to coal and water supplies. It is anticipated that the cost of energy from this station will compare favourably with that of the large hydro-electric stations in the West, which distribute their output over long distances. An exceptional advantage in this case is the convenient situation of the time zones, which change by one hour at a meridian near that on which the power station is built, thus benefiting the diversity factor in a way which is not practicable here.

NOTES ON ELECTRIC LOCOMOTIVES.

In connection with the design and construction of electric locomotives for passenger and goods trains a considerable amount of valuable information has been accumulated as a result of many experiments carried out on the Continent. More experimental locomotives have been built and tested on the Continent of Europe than anywhere else. Taking the Midi Railway, in France, for instance, no fewer than six firms were invited to submit locomotives for trial on the line extending from Villefranch to Ille, but only three of the competing firms were successful in getting their locomotives accepted. All the locomotives submitted were of the 1—C—1 type, having three driving axles and two idle axles. In one case power was transmitted from two independent motors placed closely together in the cab by means of two sloping connecting rods, each motor driving through these rods a separate jack shaft located at each end of the locomotive next to the outer driving wheels, and the jack shafts were connected to the driving wheels by means of horizontal side rods.

A second locomotive was driven in practically the same manner, the main difference in the two cases being in connection with the electrical equipment. A third type of locomotive also had two motors, but instead of being connected to a jack shaft, they were connected together through a triangular rod arrangement, the lower point of which engaged with the crank on the middle driving wheel, and the other points were coupled to the cranks on the two motors. This design, however, was afterwards abandoned. Another of these locomotives was of the geared side rod type, equipped with two motors each geared to a jack shaft placed well down between the driving wheels, the power being transmitted from the jack shaft cranks to the centre wheel by means of a triangular Scotch yoke, and from there by side rods to the two outer driving axles. The most powerful locomotive had three motors, one over each axle, and geared to a quill surrounding the axles, the quill being joined to the wheels by a flexible coupling. The locomotives accepted were those driven in accordance with the first, fourth and last-mentioned methods, and the leading particulars of these engines are given in the following table :—

	French, Thomson-Houston.	French Westing-house.	Construction Electriques du Nord et de l'Est (Jeumont).
Total weight (tons)	88	81	80
Length (M)	13·75	11·37	15·27
Wheel base (M)	9·6	8·8	10·6
Diameter of driving wheels (M)	1·3	1·2	1·4
Number of motors	2	2	3
H.P. of motors	600	600	500
Method of drive.	Coupling rods driving two jack shafts.	Gearing and Scotch yoke.	Motors geared to each driving axle.

Each of the three above firms received orders for eight additional locomotives, but they were not, it has been reported, to be exact duplicates of the original locomotives. The new locomotives were to have three driving axles and two idle axles, each driving axle being driven by two motors geared to a quill surrounding the axle, an arrangement which has been adopted with marked success in America.

It is not so much in connection with electrical designs that many Continental locomotives have proved unsatisfactory. The main troubles have originated from the transmission arrangements between the motors and driving wheels. On the Continent there has been a distinct tendency to adhere, as far as possible, to steam locomotive practice, the original idea being merely to replace the boiler and fire box of the steam locomotive with an electric motor, and to retain, as far as possible, the ordinary driving arrangements. It has been customary in many cases to transmit the power from the motor or motors to the driving wheels by means of rods and a jack shaft, and often without gearing. This plan has been adopted on many Continental railways besides the Midi Railway—as, for instance, on the Dessau-Bitterfeld line in Germany. For high-speed passenger traffic on the latter line a type of engine designated 2—B—1 has been adopted—that is to say, a locomotive having two leading axles, two driving axles, and one trailing axle. Cranks at the end of the motor shaft drive a jack shaft through vertical connecting rods, and from this jack shaft the driving wheels are driven by ordinary horizontal side rods. Breakages of the crank and jack shafts have been experienced, however. The jack shaft in this type of locomotives is subjected to a series of suddenly applied reciprocating tension strains, and these strains, it is believed, were accountable for the breakages. Great accuracy in the alignment of bearings and liberally proportional shafts are essential with locomotives constructed on these lines, but doubts have been expressed, especially in America, as to whether these precautions will entirely eliminate the trouble.

Although, apart from the crank shaft and jack shaft breakages, these locomotives have given pretty good results, it seems improbable that this type of engine will be used in future for high-speed traffic. In fact, it was decided some time prior to the war to test the 1—C—1 type, that is, a locomotive having three driving axles and two idle axles. Like the 2—B—1 locomotives, there was to be one motor placed high up in the body, but, instead of the connecting rods between the motor shaft and jack shaft being vertical, they were to slant, as on various other locomotives, at an angle of about 45°. Slanting connecting rods were used on the original Dessau-Bitterfeld goods locomotives, which, of course, run at much lower speeds, but not on the original locomotives intended for passenger service. So far as can be gathered, the tendency is, or rather was, prior to August, 1914, to slant the connecting rods as much as possible.

The experimental goods locomotives put into operation on the Dessau-Bitterfeld line were O—D—O locomotives, having four driving axles coupled and no other axles. These locomotives weigh about 70 tons, and are designed for a normal speed of 15·5 miles an hour, a speed that is not likely to lead to trouble. Despite this, however, a number of firms were invited to submit locomotives for the goods service, and it was specified that these engines should have a high centre of gravity.

For low and medium speeds the B—B Continental engine has, it seems, given pretty good results. This locomotive has two independent trucks, each having two driving axles, and on each truck a single motor is mounted, and it is geared to a jack shaft, which in turn is connected to the two driving axles on the truck that carries the motor by means of Scotch yoke.

Many of the high-speed direct-drive side-rod locomotives have given more or less trouble as the result of vibration at critical speeds, and crankshaft and jack shaft breakages have not been at all uncommon. The 1—D—1 type of locomotive built for the Silesian lines developed trouble of this kind, and it has been reported that this type was to be abandoned. The original 1—D—1 Silesian locomotive weighed over 100 tons, and had two large motors connected through slanting connecting rods to a common jack shaft coupled to the driving wheels with horizontal rods.

In place of this type of locomotive it was proposed to employ locomotives having two motors, each rated at half the output of the original single motor and with intermediate toothed gearing.

Among other Continental locomotives is the C + C type, with two three-axle trucks, each of which is equipped with two motors geared to a common jack shaft, which drives the three axles through horizontal side rods. Again, there is the B + B + B locomotive, with three two-axle trucks. Each truck carries a motor which is geared to a jack shaft, the latter driving the two axles through horizontal side rods. A type similar, so far as the trucks are concerned, is the A A + A A + A A locomotive; but in this case each of the three trucks carries two motors, and each motor is geared directly to one of the axles.

For the Silesian State railway a 2—D—1 locomotive with one large motor was designed, the drive being similar to that adopted, in the first place, on one of the Midi railway locomotives. Power from the motor is transmitted to a pair of jack shafts through a triangular rod arrangement, the upper point of which is connected to the motor crank, whilst the base connects together the cranks of the jack shafts, which in turn are connected by horizontal side rods to the driving wheels. In the case of the Midi railway

locomotive, however, there were two motors connected to the driving wheels through a triangular rod, the apex engaging with the crank on the centre driving wheel and the base connecting together the cranks of the two motors.

On the Lötschberg railway, in Switzerland, several methods of driving have been tried. The first experimental locomotive put into service on this line was of the articulated type, with two motors, one erected on each half of the engine, and each motor drove a jack shaft through a slightly slanting connecting rod, and this jack shaft was in turn connected to the driving axles through horizontal rods. The next experimental locomotive had two three-axle trucks, each carrying a motor geared to a jack shaft coupled to the three driving wheels by connecting rods and the usual side rods. The jack shaft is placed so low that the connecting rod makes a very small angle with the horizontal. In this case the motors are placed at the extreme end of the locomotive, but in a later design they have been shifted to the centre. It is believed, although nothing definite has been published, that at the high speeds this locomotive was rather hard on the track. In any case the driving arrangements in the latter, and more powerful, locomotives are different. These latter locomotives have five driving axles, instead of six. Three of these driving axles are fixed in a rigid wheel base, whilst each leading truck at the ends has one idle axle and one driving axle. On all these trucks the two driving axles are held parallel to one another, and are connected together by means of horizontal side rods. As stated above, the two motors are placed close together in the centre of the cab, and are geared to jack shafts, which in turn are connected to the centre driving wheel by a Scotch yoke to which the horizontal side rods are coupled.

There are, of course, other types of electric locomotives, but those referred to are fairly representative of Continental practice. In many cases where rods and jack shafts are used, vibrations and oscillations have been produced in the driving mechanism at certain speeds, and in some cases these vibrations and oscillations have proved sufficient to break rods, crankshafts, and yokes. By careful adjustment of bearings, it has been possible in some instances to eliminate these defects, but these adjustments involve labour and loss of time, and it has been found that shortly after such adjustments had been made, the trouble has again manifested itself. Not infrequently locomotives have been put out of action as the result of excessive vibration at certain speeds. Even the Pennsylvania Railroad locomotives are said to have developed faults of this kind, although in this case the trouble has not been serious. Up to a point this vibration increases as the speed rises until the resonance point is passed, when the vibration ceases. Especially has this effect been noticeable with locomotives having two motors driving through connecting rods on to a common jack shaft, and it has also been observed on some engines with geared motors driving the wheels through a Scotch yoke.

At first sight it appears strange that the rod drive should give rise to trouble on an electric locomotive, and not on one that is propelled by steam. But it must not be forgotten that the conditions in the two cases are not exactly analogous. The driving system in the steam locomotive terminates in the steam cylinder where the elasticity or cushioning of the steam compensates any inaccuracy to the construction. The inelasticity of the driving system of an electric locomotive is intensified where the heavy rotary members of the two independent motors are connected together by a system of rods.

In the design of high-speed locomotives for passenger service, American engineers have in the main proceeded along different lines to those adopted by engineers on the Continent. Various kinds of transmission systems have been adopted in America with a view to providing elasticity between motors and driving wheels. Locomotives have been built with the motor armature surrounding the driving axles, but coupled to the wheels through heavy spiral springs, this being known as the quill drive previously referred to. A more modern arrangement is to gear the motor to a quill surrounding the axle, the quill, as in the first-mentioned arrangement, being connected to the driving wheels by means of long spiral springs.

This design has been embodied in the latest type of locomotive put into service on the New York, New Haven, and Hartford Railroad. When the motor armatures surround the axles, the centre of gravity is, of course, low, but the springs introduce elasticity and prevent the truck receiving direct blows. The motors, however, are now placed above the axle and drive gears mounted on the quill. This type of engine has a high centre of gravity, and the quills are so spaced that they have total play of 3 in. above the axle (1½ in. above and below), which allows for irregularities in the rails. Locomotives driven in accordance with this arrangement have been built with a single motor per axle, and with twin motors for each axle, the combined capacity of the two motors being the same as that of the single motor arrangement. After a number of locomotives had been constructed with very large motors, necessitating the use of double gears, it was found that the same output could be obtained with less weight, and at less cost, by substituting two motors for one of larger size. Various advantages have been secured by adopting this arrangement. First, only one gear is required, as both motors drive through the same spur wheel; secondly, the two motors are said to be lighter, more easily handled, and cheaper to maintain; thirdly, on the New York, New Haven, and Hartford system the locomotive armatures are interchangeable with those on the motor coaches; fourthly, as the two motors are connected in series, the combination is equivalent to a single motor of twice the ordinary voltage, and, consequently, only half the amount of current has to be dealt with as compared with that taken by a single locomotive of the same output as the pair.

It will be seen, then, that modern American practice differs considerably from that in vogue on the Continent of Europe prior to the war, but judging from various reports that have been published, many of the Continental locomotives that have been described in technical journals have either been entirely rejected or reconstructed with a view to making the driving system elastic.

ALUMINIUM IN TRANSFORMERS.

These are essentially days of substitutes—many of them nasty and few particularly cheap. A good deal has been heard lately concerning the use of aluminium as a substitute for copper in transformer windings. Striving to make a virtue of necessity, M. Vidmar writes in *Elektrot. u. Maschinenbau* claiming certain advantages for aluminium which cannot all be substantiated. On the other hand, the substitute metal has certain useful characteristics which deserve to be considered, though it is doubtful whether aluminium is likely ever to be used in genuine preference to copper for transformer windings.

Since the electrical resistance of aluminium is about 70 per cent. greater than that of copper, more space is needed to accommodate aluminium windings, which have, however, the advantage of lower weight for equal conductance. If aluminium be substituted for copper windings, the transformer output for equal losses is reduced by 23 per cent. On the other hand, if the cost of the winding in a copper-wound transformer be one-third the total cost, the cost with aluminium windings is about 19 per cent. lower. In an air-cooled transformer, the copper cost is generally more than one-third of the total, and the economic advantage of an aluminium winding is correspondingly increased.

Vidmar makes certain assertions concerning the cooling of subdivided or disk windings which are criticised adversely by A. Hundt in *Elektrot. Zeitschrift*. Vidmar asserts that in an air-cooled transformer, heat is dissipated from the flat sides of the winding sections by radiation alone, and that the whole heat loss is not greater than it would be from a single cylindrical winding of equal total length and periphery. He states also that heat dissipation is more favourable when the air space between winding sections is horizontal than when the plane of the coils is vertical. Assuming the truth of these assertions, the space between winding sections may be utilised to accommodate

the larger aluminium winding, leaving the power, losses, and heating unaltered (compared with copper windings.)

Hundt points out that Vidmar's case for the advantages of air-cooled aluminium transformers depends on the cooling phenomena which he adduces. Actually, however, convection plays a considerable part in removing heat from the flat sides of disk coils, and the air spaces between the latter should be vertical (*not* horizontal) for maximum cooling effect. The temperature rise in a 60-K.V.A. A.E.G. air-cooled aluminium-wound transformer was 78° C. with the air spaces set horizontally, and only 57° C. with the air spaces vertical. With the former arrangement, the output for 57° C. temperature rise would be about 50 K.V.A. If the air space between sections were sacrificed to accommodate the larger aluminium winding in the same over-all space as a normal copper winding, the temperature rise would be yet more serious. In this connection it may be mentioned that Vidmar leaves air spaces between the coil-sections of a 500-K.V.A. aluminium transformer which he has built.

Vidmar estimates that an aluminium transformer is 14 per cent. cheaper than a copper transformer when aluminium is 40 per cent. dearer than copper, weight for weight; the cost of the transformers is the same when aluminium is 1·94 times as dear as copper. Even then the aluminium transformer is lighter. For equal cost an aluminium transformer yields, it is claimed, 17·5 per cent. greater output, but this figure depends partly on the questionable cooling assumptions noted above. An air-cooled aluminium transformer made by Vidmar for 12,500/165 v., 42 cycles, weighs 800 kg., including 524 kg. of active iron and 98 kg. of aluminium.

The space factor of the windings in an air-cooled copper-wound transformer may be about 0·14, compared with 0·3 in an oil-cooled transformer. On this basis, an aluminium-wound transformer requires 0·14 × 70 = 9·8 per cent. greater winding space for air cooling, and 0·3 × 70 = 21 per cent. greater winding space for oil cooling. In a zinc-wound transformer, the advantage of the air-cooled type is yet greater for a similar reason. About 250 per cent. greater section is needed in zinc than in copper conductors for equal conductance, so that 35 per cent. greater winding space is needed in air-cooled transformers, and 75 per cent. greater space in oil-cooled transformers, compared with copper-wound transformers in each case.

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.

(*Concluded from page* 288.)

The Association has adopted the principles of the new British Standardisation Rules, E.S.C. 72/1917, for export work, and the Association's Export Standardisation Rules, which are an abstract of E.S.C. 72, have now been translated into Spanish, Portuguese, Russian, and Chinese, and are being made use of by members with a view to popularising British standard practice abroad.

Representations were made to both the Board of Trade and the Foreign Office in connection with proposals emanating from enemy countries to export their goods after the war through Switzerland or other neutral countries so disguised as to conceal the source of origin. The Government Departments appear to be now alive to the importance of this question.

Editions of the *Journal* were published in Russian and Spanish.

The I.E.E. Conditions of Contract have, through the instrumentality of the Association, now been firmly established as the standard for the home industry.

The records of the industrial solicitor show that, whilst the number of contracts on which he has been consulted has been about the average, there has been less difficulty in adjusting points of difference.

Arrangements have been completed between the Association and the Institution of Electrical Engineers whereby research into the problems of insulation is conducted jointly by the two bodies, both of which now communicate with the Government Department of Scientific and Industrial Research through a Central Committee established by the Department, and known as the "Electrical Research Committee."

A Committee is considering the question of technical education in its relation to the electrical and allied industries.

Proposals of the Turbine and Turbo-Generator Sections respecting research scholarships are being entrusted to the care of this Committee.

A scheme is also being considered to provide for the formation of central and local Committees to deal with the selection, placing, and training of suitable overseas students.

In the section of the report relating to standardisation it is stated that representation has been established on new committees and panels dealing with the gauging of machine parts and screw threads and the electrical details of ship and aircraft equipment. Representatives took part in the British-American Conference on electrical standardisation.

A Committee has been appointed to study questions of common interest to members relating to estimating and accounting.

The Association gave evidence before Lord Buckmaster's Pre-war Contracts Committee on pre-war contracts the cost of executing which during war time had been greatly increased, and in some cases made impossible of fulfilment.

The Council made representations in the proper quarters as to the desirability of establishing a National Proving House. An expert Committee of the Association is shortly reporting on the report of the Coal Conservation Sub-Committee.

Liberal gifts of machinery and apparatus were made by members to the equipment of the laboratories and shops of Pekin University, but the war has delayed installation, and a final report from the University is not yet to hand.

The Association gave its support to the proposal of the British Empire League for an Empire Trade Mark of Origin, but with the provision that the use of the mark would be a national one, and its misuse by private groups or persons guarded against.

The creation of a co-ordinating board composed of members closely connected with the work of the various sections was successfully carried out during the year, and the board is now devoting close attention to several matters affecting the sections in common. One such subject is that of relief from the burden of contracts entered into prior to the war, and the immensely increased costs which result from wages awards made by the Government and the consequent rise in the cost of raw materials.

Sectional activity during the year has been mainly in connection with matters arising directly or indirectly out of the war—such, for example, as metal rationing, the control of imports, the right to export, pre-war contract difficulties, mitigation of difficulties generally under which manufacture is now carried on and business goodwill maintained, &c.; while the general tendency is exhibited in largely increased impulses towards research, standardisation, and education, regarded as national affairs. Directly or indirectly, most sections have come into contact with Government Departments and done much useful work. The Dynamo and Motor Section, for example, confers regularly with the Electrical Power Department of the Ministry of Munitions through an Advisory Committee (created by the invitation of the Ministry to secure economy in working and speeding up), and has obtained, through it, an Order in Council prohibiting the import of motors. Work in the direction of co-operative purchase and the settlement of special conditions with special bodies has been extended during the year.

The articles of association have been amended, limiting the membership to *bona fide* manufacturers, and making alterations in the method of electing the Council so as to give opportunity for fresh representation.

The system of tendering embodied in these agreements continues to find favour among members, but has not been extended during the year.

The work of the Association's status inquiry agents, the British Traders' Association, is under review by the Estimating and Accounting Committee.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.

An Electric Heating Pad.

The Goodwill Electric Co., of 59, East Van Buren Street, Chicago, is offering an electric heating pad for general use, a slight modification of one the company developed for the hospital field. The thermostat is mounted in the centre of the pad in a sealed box 1·125 in. in diameter and 0·25 in. deep. It is composed of two U-shaped arms of half-hard brass and tempered steel, both of which

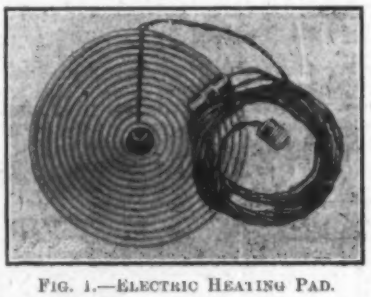

Fig. 1.—Electric Heating Pad.

are wound with a continuation of the German silver wire which forms the main heating element. The thermostat is adjusted through a slot in its container, and has a range covering all points between 100° and 180° F. Tendency to short-circuit is overcome by the helical construction, and the manufacturers claim that the current may be turned on when the pad is wet without damage.

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Electric Cooking at a Newspaper Office.

The accompanying illustration shows a neat and compact electric cooking installation which has been supplied by the British Electric Transformer Co., Ltd., of Hayes, Middlesex, to Messrs. United Newspapers, Ltd., the publishers of the *Daily Chronicle*, *Lloyd's Weekly News*, &c., for the benefit of the editorial staff; the apparatus is situated conveniently in a small room adjacent to the dining room, and provides for the preparation of teas in the afternoon and meals for the staff on night duty, about 120 meals being served daily. It comprises the following items, shown in fig. 2, all of which are of the well-known "Tricity" type.

Oven fitted with two ribbed plates, each taking 900 watts on "high" and 225 watts on "low" load—total maximum loading 1,800 watts; duplex cooker for two 2-gallon urns, each plate loaded to 850 watts on "high" and 210 watts on "low"; grill with open element loaded to 800 watts.

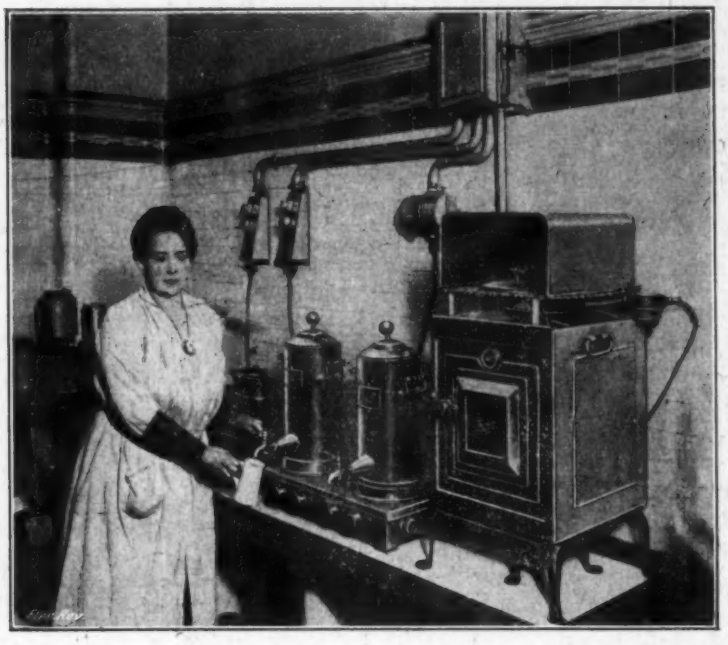

Fig. 2.—"Tricity" Kitchen at United Newspapers, Ltd.

The comfort and convenience afforded to the staff by the provision of facilities for electric cooking at all hours need not be emphasised; we are informed that the installation has given every satisfaction, and that its resources have been fully equal to the demands imposed upon it.

An equipment on similar lines, including apparatus for warming up meals brought by the employés, has been installed in another part of the building.

We are indebted to Mr. Mascord, works superintendent, for the opportunity to inspect the installation, and incidentally to make a tour through the building, which is equipped with electrically-driven printing machinery of modern and, in some respects, unique design.

An illustrated description of the plant appeared in our issue of June 3rd, 1910; since that date the lighting of some of the departments has been improved by the substitution of half-watt lamps on the semi-indirect system for the inverted arc lamps formerly used, with excellent results. The mercury-vapour lamps, however, have been retained in the publishing and press rooms, the quality of the light having been found peculiarly suitable for the kind of work done there.

Portable Electric Grinder.

One of the latest tools made by the Sun Electrical Co., Ltd., of 118 & 120, Charing Cross Road, London, W.C., is a portable electric grinder, which will be of great value in all tool rooms for the quick and accurate grinding of centres, reamers, dies, &c. It

Fig. 3.—Sun Portable Electric Grinder.

works equally well on both internal and external jobs, and will grind out holes up to 4 in. deep.

The device is very compact, the over-all length being 10½ in., and the weight only 5½ lb. A fixing arm is attached so designed as to fit into the slide rest of ordinary lathes. The grinder is fitted with a $\frac{1}{15}$-H.P. motor, running at 10,000 revs. per minute, which gives to the emery wheel the right surface speed. The dimensions of the emery wheel are 1¼ in. × ¼ in. × ¼ in.

This grinder is economical to operate, and can be run from any electric light point, being furnished complete with stout workshop flexible cord, fireproof B.C. adapter, and metal-cased switch. The motor is universal, operating on either direct or alternating-current circuits.

Outdoor Sub-station Transformers.

Our illustration, fig. 4, shows an 11,000-volt, three-phase transformer, isolating switch, and fuse, for use in the open air. It is now general practice in America and the Colonies to dispense with buildings for transformer sub-stations used in conjunction with overhead transmission lines. Static transformers can be designed with their protective switchgear to withstand complete exposure to the weather under all usual climatic conditions, and they require no attendance beyond occasional inspection.

Messrs. Johnson & Phillips, Ltd., of Charlton, London, S.E. 7, have therefore designed, both for the foreign and Colonial markets, and in view of developments in this country, a series of outdoor transformers, similar to that shown. A number of these units have been in use for a considerable time abroad, and reports prove their entire success.

This design is used for units of 50 K.V.A. and upwards, the larger transformers ranging up to 22,000 volts; the one illustrated is designed for a voltage of 11,000, three-phase.

The protected terminals are arranged to take bare connections from E.H.T. overhead transmission lines, and the transformers are oil-immersed, the insulators being designed to stand from two to three times the working voltage when wet. By removing the lid of a hand-hole in the cover all connections become easily accessible.

The weight of the transformer is supported by a platform, and suitable straps are provided for steadying purposes. The makers supply, if desired, details of a suitable supporting structure.

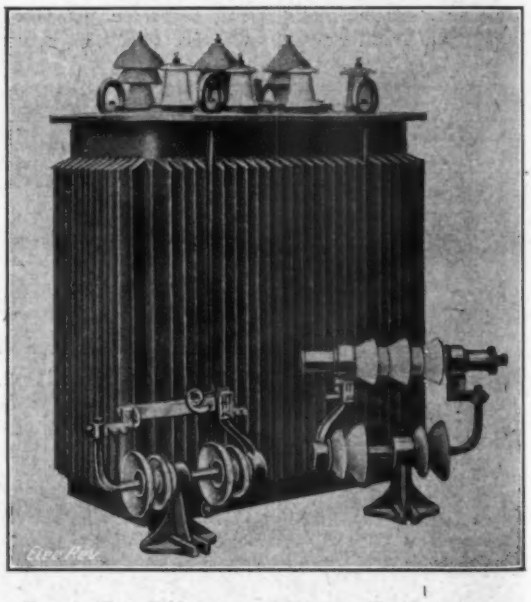

Fig. 4.—J. & P. Outdoor 11,000-volt Transformer.

An Automatic Electric Iron.

An electric iron equipped with a switch which opens automatically when the iron is not in use is announced by a United States manufacturer. A switch button is provided in the forward part of the handle, just where the thumb ordinarily rests. Under normal ironing conditions, the thumb presses against the switch button and keeps the iron in circuit; removing the thumb cuts it out of circuit. By means of this switch button, the current may be cut in and cut out at will by the operator, merely by moving the thumb. This will be found convenient when ironing the lighter fabrics, the heat being shut off when not needed, to prevent scorching.—*Canadian Electrical News.*

"Carron" Cookers at the Engineers' Club.

We recently recorded the fact that the Engineers' Club, Manchester, had substituted electric for gas cooking plant, and was highly satisfied with the results. We are now enabled to give some particulars of the apparatus, which was supplied by Carron Company, Stirlingshire, and installed by Messrs. Sharples Hill and Co., of Manchester. Fig. 5 shows the apparatus, which has been constructed from various standard Carron parts, and consists of a hot closet, boiling table, bain marie, oven, and grill, with a smaller hot closet over it, the whole being fitted up complete with switchboard and arranged for a central situation.

The main hot closet measures 6 ft. long × 2 ft. 6 in. deep × 2 ft. 9 in. high; it has sliding doors on one side, and is fitted with two shelves, making three compartments; there are four separate sets of heating elements in the bottom compartment, arranged for various degrees of heat regulation. In the hob or top of this hot closet are fitted various boiling sections at one end, and a bain marie measuring 27 in. × 24 in. × 4 in. at the other; the total loading of the boiling sections is 6 kw., and that of the bain marie

Fig. 5.—Carron Cooking Plant at the Engineers' Club.

3 kw., all the elements being arranged for heat regulation. A strong draw-off tap, with cleaning nozzle, is fitted in the bain marie.

The oven is a standard Carron model, having an available cooking space of 22 in. × 20 in. × 22 in., with top and bottom heating elements rated at 5 kw., each having heat regulation; the door carries a glass inspection window, thermometer, and ventilator. Over the oven is fitted a large griller and toaster, having a working area of 22½ in. × 16 in., and a height of 8 in. It is white porcelain enamelled throughout, and has a gravy collecting tray, brander, and grid, whilst the elements are rated at 6 kw., with sectional regulation. Above this is a small hot closet for the grill service; it has only two compartments, and is heated by separate heat from the grill only.

All the wiring is conducted to one switchboard, which, as will be seen, is carried on pillars at the back of the large hot closet, and on which are mounted the switches, fuses, and pilot lights.

The total loading of the equipment is 23 kw.; it is finished in bright black stove enamel, with raised parts, hob, and mouldings nickel-plated and polished.

The equipment has been in use for some months, and the chef is quite satisfied with its performance—as would be anticipated.

THE MECHANICAL DESIGN AND SPECIFICATION OF THE TURBO-ALTERNATOR ROTOR.

By S. F. Barclay, Ph.D., B.Sc., A.M.I.E.E.

(*Abstract of paper read before the* Institution of Electrical Engineers.)

The objects of this paper are to review the conditions underlying the mechanical design of the high-speed alternator rotor, and to suggest a specification for the guidance of the purchaser's technical adviser.

Nothing has led to the development of electrical machinery from the mechanical point of view more than making alternators suitable for direct coupling to high-speed steam turbines. With the advent of peripheral speeds of over 4½ miles per minute the unsound construction of earlier times has disappeared, and the modern turbo-alternator rotor is not surpassed as a high-class engineering production. The need for the use of material of the highest grade is obvious when it is recalled that at the periphery of a 31-in. diameter rotor running at 3,600 r.p.m. a mass of 1 lb. exerts a centrifugal force of 2½ tons, and in the case of a 5,000-kw. alternator at 3,000 r.p.m. the total centrifugal force at the normal running speed is about 15,000 tons. The kinetic energy of such a rotor at the normal running speed is about 7,000 ft.-tons—equal to the muzzle energy of 23 75-mm. field guns, and sufficient to hurl 380 lb. of steel a distance of 6 miles. It is clear that eliminating weakness of construction by the lessons of failure is not a permissible policy with such machinery. The precise nature of the duty at the various parts of the rotor must be thoroughly investigated, the material employed must be of the highest grade, and the factor of safety must have a satisfactory value.

It is somewhat remarkable that the specifications drawn up by consulting engineers make little attempt to ensure mechanical excellence, although the electrical performance is usually very fully stipulated. But one never sees stipulated the all-essential permissible ratio between the stress and the quality of the material *in the direction of the stress*. An excessive overspeed test is undesirable, and does not necessarily establish mechanical soundness.

With the advent of large outputs at high speeds the salient-pole rotor has now disappeared. There still remains, however, some discussion as to the advantages of the solid as compared with the laminated rotor. In a normal turbo-alternator the output is limited by the rotor heating, and it is obviously a great advantage of the solid rotor that the ventilating channels can be arranged to secure the best cooling effect, whereas with the laminated rotor they have to be provided where mechanical considerations permit. The essential weakness of the laminated rotor is the presence of the central hole through which the shaft passes. With a 3,500-kw. alternator at 3,000 r.p.m. the maximum stress on the inner fibres exceeds the average stress by about 20 per cent. In addition to the stress caused by the centrifugal force, there is to be considered the stress due to the shrinkage fit of the stampings on the shaft; to ensure that the core shall remain tight on the shaft when running at the overspeed, the amount of the shrinkage must exceed the amount by which the core opens due to the centrifugal force. This requirement gives an appreciable increase to the stress in the core disks. Just at this part of the core disk where the stress is a maximum, the strength is very considerably reduced by the keyway cut into the lamination.

The solid rotor has the great advantage that the bursting stress is always less than the stress in the tooth, and the former stress has, therefore, never to be considered. Comparing the hoop stress for a laminated and a solid rotor for a 3,750-kw. alternator, even with a much deeper tooth the maximum stress in the forged rotor is only 13,800 lb., against 34,500 lb. in the laminations. Material for the core disks is prepared by rolling down hot slabs into sheets of the thickness required. No matter what care the manufacturer may exercise, some variations in the finished sheet are unavoidable. Minute local imperfections that would be without effect on a fairly thick plate may appreciably weaken a thin plate. Since material of this kind is inherently less dependable than a high-class forging, the factor of safety should be higher than with the solid rotor, but due to the weakening effect of the central hole the designer has to be content with a lower factor of safety.

To meet the demands of the electrical engineer for steel sheets having a high tensile strength, some manufacturers have taken advantage of the additional strength given by cold working. The effect of the cold working with large thin sheets is essentially somewhat uncertain, and such material cannot be regarded as being of a high grade.

With regard to the weakening effect of punching metal sheets, metal that was quite ductile before punching is found to be brittle round the punched edge. It is most important, therefore, that the core should be assembled in a jig and be bored out, since otherwise there would be brittleness and weakness at the part subjected to the greatest intensity of stress.

An entirely satisfactory high-tensile plate could be produced using nickel-chrome steel, but a rotor constructed with such plates would be more expensive than a solid forged carbon steel rotor, and would be less satisfactory mechanically and electrically.

Practically always, the running speed is above the first critical speed, and with large outputs at 3,000 r.p.m. the running speed may be above the second critical speed. For mechanical soundness it is desirable to assemble the laminations under heavy end pressure. Under the combined action of vibration, stress, and pressure, the minute undulations in the laminations are removed, and in the course of time the end pressure, which might have been initially 200 tons, is found to have disappeared. With a newly constructed rotor the critical speed may have a satisfactory value, but after some running there may be a lowering of the critical speed and some vibration may result. The author has had experience of several cases of slight incurable vibration with laminated rotors that has developed after prolonged running, but in only one case was the vibration so bad that the rotor had to be reconstructed.

When high-grade forgings are available the solid forging is undoubtedly preferable for all sizes of rotors for polyphase work. For outputs in excess of 3,000 kw. at 3,000 r.p.m. the

laminated construction should be employed only when it is impossible to obtain suitable forgings.

For large-diameter rotors at medium speeds thick plates are sometimes employed instead of laminations. This construction is preferable to using thin sheets, but the weakness of the centre hole and the high hoop stress, together with the unsuitability of using rolled plate with a pronounced fibre subjected to high stress in all directions, are still present, and when the critical speed is below the running speed, trouble with it is equally if not more pronounced.

Another alternative is the construction of using plates of considerable thickness held together with through bolts with a short shaft length at either end and no central hole. The great weakness of this construction is the difficulty of making the bolts satisfactory. The deflection is due almost entirely to the elongation of the bolts, the area of the plates being large compared with the area of the bolts and the compression of the plates therefore negligible. A very slight elongation of the bolts takes all compression off the plates, and consequently at the underside of the rotor the plates are out of contact. Each time the rotor turns round, stress in addition to the initial stress is thrown on the bolts. In the case of a 1,500-R.P.M. rotor this intermittent superimposed stress is applied and removed over two million times a day. It is claimed for the construction that the variation of stress can be maintained at so low a value that in spite of the rapid variation the duty is within the capacity of the steel. It is to be remembered, however, that the calculated stress may be considerably exceeded. With one case that came to the author's notice of a 6,000-KW. 1,500-R.P.M. alternator constructed in this way, it was found that after 2½ years' running some of the plates at the centre of the core had moved slightly out of centre. Where initially there had been a good fit, there was found to be a clearance on the spigot and in the bolt holes of 1/50 in.

Since the bolt area in tension is small compared with the rotor weight, the deflection in the body of the core is considerable and hence the critical speed is very low. Vibration is damped, and such a rotor has no real critical speed, but there may be sufficient vibration to be appreciable.

Such a construction can be seriously considered only with relatively large and relatively low-speed rotors, and is only to be employed when forgings are unobtainable.

The forged rotor having no central hole is very much stronger in its resistance to bursting than is the laminated rotor. It can be shown mathematically that a minutely small hole through the centre of a rotating cylinder doubles the stress. In addition to the gain due to the omission of the

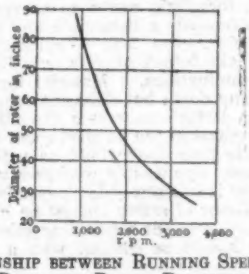

Fig. 1.—Relationship between Running Speed and Maximum Desirable Rotor Diameter.

hole, there is the greater area of steel to carry the load, and altogether the bursting stress is so low that it has not to be considered.

The maximum stress with the solid forged rotor is always in the tooth, but the stress never reaches a high value, the maximum rotor diameter being determined by other considerations.

With the type of winding now in universal use, of concentric coils of flat copper strip, there is a fairly clearly defined limit to the rotor diameter that may be employed for a given speed. There are to be considered the stability of the end windings exterior to the core, the pressure on the insulation between turns, and the retention of the end windings against the action of centrifugal force. In the case of a 5,000-KW. alternator at 3,000 R.P.M. with a 31-in. diameter rotor, when running at the overspeed of 20 per cent. above normal, the average value of the maximum pressure on the insulation is about 5,000 lb. per sq. in. Pure hard mica is the only material that is really suitable for the purpose. The thickness of the insulation between turns of 0.01 in. cannot be exceeded without unduly adding to the size of the machine for a given output.

Under steady compression between flat surfaces mica can stand great loading before failing. In service, however, the conditions are not nearly so ideal. There is always some degree of high-frequency vibration present, and the surface of the copper is never quite flat. For these reasons a big margin of safety is necessary.

Owing to the difficulty of retaining the rotor end-windings, the author believes that for a normal speed of 3,000 R.P.M. a 30-in. diameter rotor will come to be regarded as the maximum desirable size. The peripheral speed of such a rotor is 23,120 ft. per minute. In fig. 1 is shown the relationship between the angular speed and the maximum desirable rotor diameter.

The exciting energy required to drive the flux through the rotor may be of the order of 15 to 20 per cent. of the full-load excitation. It is important, therefore, that the permeability should be as high as possible consistent with satisfying the mechanical requirements. A carbon steel, containing about 0.38 per cent. carbon, after oil treatment has an ultimate strength of 38 tons per square inch, a yield point of 22 tons, an elongation of 22 per cent. on 2 in., and a contraction of area of 40 per cent. It is used for such purposes as railway axles, and is admirably suitable for alternator rotors. The permeability of this steel is quite good.

It is usual to express the factor of safety in terms of the ultimate strength—which is not quite logical, since it is the yield of the material that marks the limit of safety, and not the actual fracture. The author is of the opinion that the factor of safety should always be expressed in terms of the yield point, defined as being the stress at which there is a complete yield of the material that is observable to the eye. The maximum stress in the solid forged rotor is in the teeth. The stress is unidirectional and constant, and a factor of safety of 2 to 1 on the yield point is satisfactory. With this factor of safety the maximum permissible tooth stress with the quality of steel suggested is 11 tons per sq. in. With a well-proportioned rotor having a diameter of 31 in., the maximum tooth stress at 20 per cent. overspeed is about 9½ tons per sq. in. There must be some saturation in an alternator to give it magnetic stability. With a turbo-alternator the necessary saturation must be provided in the rotor teeth—that being the only part of the machine where a high density is permissible. On the other hand, if the saturation is carried too far, the loss in the teeth becomes excessive. In general, it will be found that with a stress of about 10 tons per sq. in. the corresponding tooth density is as high as it is desirable to employ, and the oil-hardened carbon steel therefore satisfies the electrical as well as the mechanical requirements.

If an alloy steel were employed with the object of being able to use a smaller tooth to give increased winding space, the increased magnetisation loss due, not only to the higher tooth density, but also to the lower permeability would more than offset the gain due to the increased copper space. An alloy steel for a large rotor forging is inherently not so reliable, there being a greater probability of internal flaws being present. A hole should always be bored through the forging when an alloy steel is used, to see that there are no internal flaws, and the effect of the hole is more than to double the hoop stress, so that the body of such a rotor actually would be weaker than if a carbon steel were used.

An interesting case came to the author's notice a few years ago of a rotor forging breaking just where the shaft merges into the body of the core. The steel used was 3½ per cent. nickel, having a yield point of 29 tons, and an ultimate strength of 46.5 tons per sq. in., and an elongation on 2 in. of 22 per cent. It was found that a huge internal cavity had been caused by the operation of forging. In another case a high carbon steel was employed having the composition of 0.61 carbon, 0.59 manganese, and 0.23 silicon, and the tensile properties of ultimate strength 49 tons per sq. in., yield point 22 tons to the sq. in., elongation on 2 in. 18 per cent., and reduction of area 32 per cent. After being in service for 3½ years the forging failed with a fatigue flaw in the neck of the journal. A micro-examination showed that the steel had not been properly heat treated, and had a large grain size. Such a steel, more particularly in the absence of correct heat treatment, is not at all suitable for a high-speed rotor.

The use of improper steels of this kind, and bad mechanical design, have led to a number of failures that have given rise to the feeling that the solid forged rotor is less reliable than the built-up design. There is no doubt that provided the right kind of steel is used, correctly forged and correctly heat treated, and that the mechanical design is sound, the solid forged rotor is by far the best construction, and the author has never heard of a single failure when these conditions have been observed.

(To be continued.)

Discussion in London.

Prof. A. B. Field said that the design of large rotors had now become a mechanical problem. Solid forgings were necessary with a speed of 3,000 R.P.M., and apparently the author chiefly had this speed in view when he wrote his paper. The author mentioned the great difficulty of making satisfactory bolts when plates of considerable thickness were used, and held together with through bolts, with a short length of shaft at either end, and no central hole. The statements made with regard to these bolts, he thought, were quite misleading, as the actual stress was 10 times larger than was stated. These stresses varied, but the speaker knew of large machines which had stood them satisfactorily for five years. He agreed with the author that when the plate construction was used the rotor had no critical speed. He had made a similar statement himself some time ago, at which he had arrived from a theoretical point of view. Referring to the quenching of steel, the speaker did not quite see how this could be done properly when large masses of 30 or 40 tons were handled. When speaking of the limit of forging size, the author seemed to be in doubt himself, and he thought it was preferable to bore a hole down the centre of large forgings. He endorsed the author's remarks on

chrome-steel; this steel was most desirable in spite of its electrical faults, and should be used except in small machines, when other qualities became cheaper and were quite as good.

Considering the test pieces spoken of, he thought they should be taken from the centre of the ring. In the case of chrome-nickel steel, instead of one, two or three test pieces ought to be taken, and where large masses were concerned the test piece should come from the centre of the mass, and not from the outside edges.

Mr. F. H. Clough, in the main, agreed with the author, but several statements had been made from which he must differ. Apparently the author condemned all laminated rotors; he could not agree with this view, and he had never come across faults such as were mentioned by the author, even with the largest types of laminated rotors. The stresses involved came on and went off gently as the speed rose or fell, and it was, therefore, not essential to use material of high elongation. By using cold punchings he thought better ventilation could be obtained. With laminated rotors 60 per cent. better ventilation could be obtained than with the solid type. Referring to the question of critical speed, the speaker said that with speeds of 3,000 r.p.m. he had known machines which were perfectly safe. He did not think it was any longer possible to avoid critical speeds, and it did not, therefore, matter much when they occurred.

Dr. S. P. Smith congratulated the author on his paper, which, he said, could not have appeared at a better time. He said it ought to give confidence to some consulting engineers and nervous people generally, pointing out that it showed that British engineers and designers could hold their own in this respect. He had strong views on this subject, and said it would serve a better purpose if engineers inserted a clause in their specifications stating that machines must be built as well as designed by British engineers, instead of asking makers to point to similar or larger machines of their own make before they could take up the work, as some of them now did. He did not think the author had mentioned the fact that when plates were rolled cold there was a tendency for them to become thicker at the centre than at the edge. He was informed this was due to a fault of the rolling mill, and care must therefore be taken in building rotors to stagger these rotor plates, in order to guard against the rotors becoming longer at the centre than at the periphery. He had known a rotor to be 1 in. shorter at the periphery than at the centre due to this cause. Referring to short-circuit losses, he said that the heat generated on short-circuit was much greater than the same current and the same power factor (even at zero p.f.) would produce on load. This he attributed to the rotor ampere-turns being very great, they therefore caused saturation, and offered a bad path. He could trace no relation between loss on load and on short-circuit, and at the present time he thought the latter loss was put at much too high a figure. He thought the only way of getting at these losses was to make a heat balance, but it was possible they had no meaning at all.

Mr. A. R. Everest did not agree with the objects of the paper as set out by the author. He thought care must be taken not to standardise one maker's design to the exclusion of the designs of other makers or firms. He said the author's arguments in favour of the solid rotor were wrong, because he first said that rotors with a hole down the centre were weak, and, later, he advised that a shaft should be used for large machines because blades became weak. He thought that everything came back to the temperature of the rotor, and, therefore, to the ventilation. The rotor temperature was limited by the temperature of the windings which, in turn, was limited by the insulation specifications.

Mr. H. W. Taylor supported the author in his views, and he thought that the author's description of the lantern slides shown ought to be included in the paper. From the operating engineer's point of view some of them might begin to wonder how long it would be before their machines broke down. Until reading such a paper, some of them had no idea the steel used contained so many latent defects and weaknesses. Referring to ventilation, he thought it was absolutely necessary that all ventilating ducts should be easily accessible for cleaning purposes. With regard to the short-circuit heating, as it was so much greater than the same current produced when on load, he thought that if a short-circuit test was carried out and proved to be satisfactory they should then be quite satisfied that the machine was good for ordinary load conditions.

Dr. S. F. Barclay, in reply, said he agreed with Prof. Field's remarks up to a point. The whole point in connection with plates was the construction and reliability of the bolts. It was difficult to obtain a good fit, and unless the plates were well finished and a perfect fit they must be condemned. The question as to what was the largest mass of steel that could be worked had been in argument for some time, and there was certainly a difference between the centre and outside of such masses when the material was tested. He did not condemn laminated machines, as Mr. Clough suggested, until the larger sizes were reached, but the solid type was certainly preferable in most cases. With Mr. Clough's statement as to ventilation he could not agree. As to Dr. Smith's remark that plates were thicker at the centre, he had heard of this, but was not sure if it was inherent. All plates suffered in this way, and it was due to faulty machines when the plates were made. He thought consulting engineers in the past had gone too much into electrical detail, and they had neglected the mechanical construction. Having a hole through the centre of a laminated rotor certainly weakened it, but there was no objection to putting a hole through a solid rotor or cylinder on which no work had previously been done. There was no reason to say that laminated rotors could be better ventilated because the best place to put the ducts was immediately under the coils. There was very little dirt or dust deposited in the ventilating ducts themselves; it was all carried through into the end coils, and if these could be cleaned properly the ducts themselves did not matter very much.

Discussion at Leeds.

Mr. W. M. Selvey observed that Dr. Barclay's paper was one which they had been waiting for for quite a number of years. It was, he thought, the outcome of a paper delivered some years ago by Prof. A. B. Field. They had then criticised rather adversely the method of holding plates together by bolts in order to have the centre of the rotor unpierced by a hole. A little previous to that time they in England were not interested in making very large machines. The Americans were then a long way ahead of the British in that direction. With regard to flaws, they were given to understand in these matters that if they went to "the approved maker" they need have no misgiving with regard to internal flaws. They were up against two very big questions in modern rotors. The first was the difficult problem of supporting the end turns. The second was the question of cooling not the end turns, but the portion which passed through the slot. It had been his good fortune during the last two or three weeks to examine some four or five designs of 25,000 kw., and there were some striking differences in principle as to the way in which rotors were made. There was no particular feature of a rotor which had given more trouble to designers than the cylindrical part of the drum enclosing the end turns. Generally speaking, that had not been made of late in a solid piece, as Dr. Barclay mentioned. Almost invariably, except in low-speed rotors, that part ought to be made of magnetic steel, and it had been found most difficult to cool. It was inaccessible, and a place where dirt collected, and trouble had arisen through heating at the ends. The explanation put forward in connection with this heating at one time was that of unbalanced loads, but that had not always been borne out.

Mr. J. Shepherd (Leeds), dealing with ventilation, said that when very large units were used it would be necessary to abandon air cooling, and to adopt some form of liquid cooling.

Mr. Hefford (Leeds) said Dr. Barclay had not quite demonstrated to him the safety of making large rotors of one piece of steel. He did not see how they could deduce from microscopic examination the actual state of steel in the centre of a large rotor of 40 or 50 in. diameter. Dr. Barclay had remarked that an alternator with a solid rotor could quite well be designed to stand a short-circuit at the terminals without damage. He (Mr. Hefford) found that alternator builders were very chary of agreeing with this view, no matter what type of rotor was put forward. Dealing with plates, it was obvious there must be a high initial strain on plates when they were shrunk on the shaft, or else over-speed tests must tend to loosen them. Dr. Barclay had stated that an entirely satisfactory high tensile plate could be produced by using nickel-chrome steel. He, the speaker, had a rather large alternator going through his hands at the present time, and there had been great difficulty in producing a rotor for that machine. They tried several types of steel, eventually using rings shrunk on the shaft, and they had to obtain nickel-chrome steel before they could get the mechanical tests satisfactory. The speaker was not quite sure they were on right lines with regard to the ventilation of rotors by putting the fan on the rotor. By putting a fan in this position it created induced draught, or suction, where the shaft passed through the casing to the alternator. He had known cases where there were fans on either end of the rotor drawing air in and blowing it through the rotor and the stator, both at the same time, but he thought a fan for the rotor and another for the stator was preferable. One firm met the difficulty of cooling coils in the rotor by actually enclosing the winding in a thin metal case. He agreed with Dr. Barclay that an over-speed test of 20 per cent. was quite ample.

Mr. Wilson Hartnell (Leeds) said the paper was an instance of the direction in which engineering was tending, every part of the material used being carefully examined in a scientific manner.

Mr. Brown (Bradford) said this paper showed the necessity of thoroughly understanding the strength of materials. He noticed that under the heading of rotor windings, Dr. Barclay dealt with the question of insulation, and advocated mica. He would like to know whether Dr. Barclay advocated the use of mica for low-pressure machines up to 5,000 or 6,000 kw.

Dr. Barclay, in reply, said the laminated rotor did not apply only to small machines, as there were makers in this country building machines of 5,000 or 6,000 kw. on this principle, though, in general, laminations were only used for small machines. There was not much difficulty in cooling that part of the rotor coil that was buried in the core; it was the end turns that presented the difficulty. The problem was to get as much air through the rotor as they could. The fact that the coils were hotter at one end than the other did not

matter if the hotter end was cool enough. Unbalanced load did not seem to have much effect in heating the end bells. Recently they had some cases of running with great unbalanced loads where no apparent heating was noticed. The whole difficulty of cleaning was that if they could get the holes in line they might clean the duct, but not the winding, and if dirt got caked into the winding it was impossible to get it out. There was no difficulty, if there was any object in doing so, in providing holes in the disk pieces. He fully agreed with Mr. Shepherd's remarks concerning the difficulties of ventilation when they came to the big sizes, but so far as 30,000 KW. was concerned there was no difficulty in getting the air through. He had seen machines of 5,000 KW. short-circuited many times, but nothing whatever happened. Mr. Hefford's remarks were very interesting concerning the construction of his big rotor, and one could appreciate the need for using nickel-chrome steel for the plates. The question of filters was a very important one. A leading firm of makers had told him recently that their filters would not eliminate greasy particles. No doubt the fault of most filters was that they let the grease pass into the machine. He had seen two machines of identical size running side by side; one had a filter, the other had not, and while the former was gummy and sticky, the latter was absolutely clear. No doubt filters did more harm than good if 95 per cent. of the dirt was removed while 5 per cent. was left to stick to the plates. In reply to Mr. Brown's question, he (Dr. Barclay) used mica, which in every case seemed to him to be the only reliable material.

AMERICAN EXPORTS OF ELECTRICAL GOODS.

The following figures, showing the exports of electrical goods from the United States during the year ended June, 1916, are taken from the recently-issued trade statistics; figures for 1914-15 have been added for purposes of comparison, and notes of any increases or decreases given :—

Telegraph instruments.—

	Dollars. 1914-15.	Dollars. 1915-16.		Dollars. Inc. or dec.
To Denmark	11,000	17,000	+	6,000
,, Canada	14,000	26,000	+	12,000
,, Central America	8,000	8,000		—
,, Mexico	17,000	41,000	+	24,000
,, Colombia	1,000	1,000		—
,, Argentina	—	2,000	+	2,000
,, Cuba	1,000	2,000	+	1,000
,, Brazil	1,000	1,000		—
,, Other countries	23,000	51,000*	+	28,000
Total	76,000	149,000	+	73,000

* Great Britain, $23,000; New Zealand, $6,000.

Telephone instruments.—

To United Kingdom	132,000	582,000	+	450,000
,, Canada	205,000	161,000	−	44,000
,, Central America	56,000	20,000	−	36,000
,, Mexico	8,000	20,000	+	12,000
,, Cuba	76,000	80,000	+	4,000
,, Brazil	51,000	48,000	−	3,000
,, Colombia	9,000	11,000	+	2,000
,, Ecuador	2,000	11,000	+	9,000
,, Japan	6,000	74,000	+	68,000
,, Australia	405,000	62,000	−	343,000
,, Other countries	199,000	260,000*	+	61,000
Total	1,149,000	1,329,000	+	180,000

* Italy, $137,000.

Other electrical instruments and appliances.—

To Canada	2,253,000	2,693,000	+	440,000
,, Mexico	244,000	314,000	+	70,000
,, Panama	300,000	212,000	−	88,000
,, Cuba	211,000	558,000	+	347,000
,, Argentina	191,000	412,000	+	221,000
,, Brazil	255,000	497,000	+	242,000
,, Japan	306,000	411,000	+	105,000
,, Philippine Islands	159,000	177,000	+	18,000
,, Australia	623,000	520,000	−	103,000
,, United Kingdom	1,950,000	3,490,000	+	1,540,000
,, Other countries	1,660,000	4,689,000*	+	3,029,000
Total	8,152,000	13,973,000	+	5,821,000

* France, $592,000; Italy, $910,000; Norway, $678,000; Russia, $452,000.

Gas engines, stationary.—

To Canada	83,000	58,000	−	25,000
,, Argentina	3,000	4,000	+	1,000
,, Australia	21,000	32,000	+	11,000
,, Europe	51,000	146,000	+	95,000
,, Other countries	262,000*	112,000	−	150,000
Total	420,000	352,000	−	68,000

* Russia-in-Asia, $197,000.

	Dollars. 1914-15.	Dollars. 1915-16.		Dollars. Inc. or dec.
Electric motors.—				
To United Kingdom	292,000	380,000	+	88,000
,, Canada	514,000	638,000	+	124,000
,, Panama	40,000	102,000	+	62,000
,, Mexico	81,000	49,000	−	32,000
,, Cuba	136,000	140,000	+	4,000
,, Argentina	30,000	54,000	+	24,000
,, Brazil	55,000	52,000	−	3,000
,, Chile	87,000	91,000	+	4,000
,, British India	83,000	69,000	−	14,000
,, Japan	303,000	139,000	−	164,000
,, Australia	634,000	686,000	+	52,000
,, South Africa	67,000	154,000	+	87,000
,, Russia-in-Europe	2,000	614,000	+	612,000
,, Italy	42,000	147,000	+	105,000
,, Other countries	453,000	904,000	+	451,000
Total	2,819,000	4,219,000	+	1,400,000
Steam engines, stationary.—				
To Canada	103,000	142,000	+	39,000
,, Cuba	60,000	133,000	+	73,000
,, Mexico	8,000	17,000	+	9,000
,, Brazil	6,000	2,000	−	4,000
,, Philippine Islands	—	12,000	+	12,000
,, Other countries	121,000	106,000*	−	15,000
Total	298,000	412,000	+	114,000

* Venezuela, $18,000.

Electric locomotives.—

To Canada	110,000	72,000	−	38,000
,, Panama	158,000	—	−	158,000
,, Mexico	10,000	3,000	−	7,000
,, Bolivia	14,000	—	−	14,000
,, Chile	15,000	19,000	+	4,000
,, China	—	33,000	+	33,000
,, Brazil	—	12,000	+	12,000
,, Russia-in-Europe	—	146,000	+	146,000
,, Bermuda	—	96,000	+	96,000
,, Other countries	17,000	71,000	+	54,000
Total	324,000	452,000	+	128,000

Dynamos and generators.—

To Canada	246,000	330,000	+	84,000
,, United Kingdom	832,000	204,000	−	628,000
,, Panama	52,000	17,000	−	35,000
,, Mexico	36,000	9,000	−	27,000
,, Cuba	35,000	141,000	+	106,000
,, Brazil	3,000	4,000	+	1,000
,, Peru	35,000	8,000	−	27,000
,, Japan	301,000	88,000	−	213,000
,, Australia	76,000	24,000	−	52,000
,, Spain	—	34,000	+	34,000
,, Other countries	397,000	610,000	+	213,000
Total	2,013,000	1,469,000	−	544,000

Fans.—

To Canada	17,000	23,000	+	6,000
,, Argentina	18,000	63,000	+	45,000
,, Brazil	7,000	7,000		—
,, China	49,000	18,000	−	31,000
,, British India	44,000	92,000	+	48,000
,, Japan	19,000	11,000	−	8,000
,, Australia	12,000	21,000	+	9,000
,, United Kingdom	30,000	20,000	−	10,000
,, Other countries	62,000	102,000	+	40,000
Total	258,000	357,000	+	99,000

Arc lamps.—

To Canada	10,000	8,000	−	2,000
,, Brazil	2,000	2,000		—
,, Other countries	19,000*	9,000	−	10,000
Total	31,000	19,000	−	12,000

* United Kingdom, $10,000.

Metal filament lamps.—

To Russia-in-Europe	6,000	115,000	+	109,000
,, Russia-in-Asia	26,000	9,000	−	17,000
,, United Kingdom	35,000	87,000	+	52,000
,, Canada	62,000	135,000	+	73,000
,, Mexico	20,000	86,000	+	66,000
,, Cuba	74,000	172,000	+	98,000
,, Argentina	31,000	82,000	+	51,000
,, Brazil	39,000	101,000	+	62,000
,, Australia	25,000	92,000	+	67,000
,, Other countries	155,000*	403,000†	+	248,000
Total	473,000	1,282,000	+	809,000

* Italy, France, and Spain, $10,000 each.

† South Africa, $57,000; India, $21,000; China, $67,000.

	Dollars. 1914-15.	Dollars. 1915-16.	Inc. or dec.	Dollars.
Carbon filament lamps.—				
To Argentina	8,000	11,000	+	3,000
,, Canada	11,000	18,000	+	7,000
,, Mexico	23,000	14,000	−	9,000
,, Brazil	5,000	7,000	+	2,000
,, Other countries ...	55,000*	95,000†	+	40,000
Total	102,000	145,000	+	43,000
Insulated wire and cables.—				
To France	150,000	150,000		—
,, Norway	129,000	318,000	+	189,000
,, United Kingdom ...	272,000	663,000	+	391,000
,, Spain	36,000	87,000	+	51,000
,, Canada	137,000	148,000	+	11,000
,, Panama	195,000	236,000	+	41,000
,, Mexico	42,000	58,000	+	16,000
,, Cuba	166,000	281,000	+	115,000
,, Brazil	143,000	286,000	+	143,000
,, Australia	64,000	66,000	+	2,000
,, Other countries ...	578,000	864,000	+	286,000
Total	1,912,000	3,157,000	+	1,245,000
Static transformers.—				
To United Kingdom ...	37,000	44,000	+	7,000
,, Spain	1,000	133,000	+	132,000
,, Canada	73,000	132,000	+	59,000
,, Panama	19,000	50,000	+	31,000
,, Mexico	32,000	17,000	−	15,000
,, Cuba	46,000	32,000	−	14,000
,, Brazil	36,000	94,000	+	58,000
,, Chile	10,000	17,000	+	7,000
,, Japan	1,000	4,000	+	3,000
,, Australia	54,000	70,000	+	16,000
,, Italy	37,000	84,000	+	47,000
,, Other countries ...	278,000*	316,000†	+	38,000
Total	624,000	993,000	+	369,000

* India, $99,000. † South Africa, $60,000.

* United Kingdom, $10,000.

† Russia-in-Europe, $18,000; Australia, $6,000.

REVIEWS.

Steam Turbines. By James Ambrose Moyer, S.B., A.M. Third Edition, revised and enlarged. London: Chapman and Hall, Ltd. Price 16s. 6d. net. Pp. ix + 468.

That the present book, which was first published in 1908, should have reached its third edition, bears witness to its usefulness to a section at least of that large number of engineers now interested in the steam turbine. The first edition, appearing when treatises on the turbine were fewer, was noticeable among its competitors by reason of the practical manner in which certain problems of design were approached, and it was therefore a really useful book to those who sought working rules for design rather than the generalities and mathematical disquisitions which formed the bulk of the earlier turbine literature. The present addition retains these points of value, but one is disappointed to find by no means so great an advance along the same lines as might reasonably have been hoped for. The treatise is, in fact, worth a far more drastic revision and development than it has received.

The contents of the work fall naturally into two parts, certain chapters and sections being devoted to the calculations necessary in design, and the remainder being more or less of a general descriptive nature. The former part alone justifies the inclusion of the book in a draughtsman's library. After a few introductory pages the reader is taken through the elementary theory of heat and the use of the entropy chart in a manner well suited to the needs of the average draughtsman, and always with a view to the practical application of the principles to the behaviour of steam in a turbine. The treatment of the subject is good, and should rob the name of entropy of its terrors to the uninitiated, for by means of the Mollier diagram—of which the one issued with the book is the best we have seen—all computations concerning the adiabatic expansion of steam are brought within the scope of the least mathematical of designers. The chapter contains, however, one blunder which should never have been permitted in a third edition. On page 16 the author, in dealing with the available work in a pound of steam, as illustrated by the P.V. diagram, falls into grievous error in treating the area under the curve before expansion as negligible to turbine designers. A little arithmetic will show that it is by no means negligible, for with steam at 165 lb. absolute pressure, superheated 100 deg. Fahr., and expanding down to a 28-in. vacuum, the available energy represented by the despised area is more than 97 B.Th.U. per lb., or nearly 30 per cent. of the total available energy.

The next chapter deals with the design of nozzles and, like the former one, is clear and practical in its treatment of the subject, so that the student can see exactly how the correct proportions of a nozzle can be obtained for any condition of working. It might, however, have been more enlightening to such readers to have calculated the flow through the throat of an expanding nozzle from the heat drop between the initial and the critical pressure, thus avoiding Grashof's formula, and bringing the calculation into line with that used for determining the outlet conditions. Considerable space is next devoted to the design and lay-out of blading, both for impulse and reaction machines; but, as in the case of the nozzles, the practical problems of manufacturing and fixing them are hardly referred to. In discussing the calculations for the design of reaction turbines, Mr. H. M. Martin's well-known treatise on the steam turbine is largely drawn upon.

The various sources of loss in steam turbines are given a chapter to themselves, but this comprises a few pages only, and is practically confined to a discussion of disk and blade rotation losses. Dummy leakage is, however, dealt with in another connection elsewhere in the book. Another short chapter on methods of correcting steam turbine tests for different steam conditions explains merely the method of applying the manufacturer's correction curves and data, and, curiously enough, does not even mention the easy and simple method of making comparison between turbines on the basis of their respective efficiency ratio.

The longest chapter in the book, comprising nearly one-fifth of the whole work, deals with "Commercial Types of Steam Turbines." It can hardly be given a word of commendation. The matter is too badly selected, badly arranged, and too much out of date to give anything like a fair idea of modern turbine practice. The de Laval turbine is given 19 pages. The Parsons type, which, we read with astonishment, "differs from that commonly known as de Laval principally in the substitution of stationary blades in the place of nozzles," occupies 25 pages, and illustrates nothing but the practice of the Westinghouse and Allis-Chalmers companies. The Fullagar method of balancing, first introduced by Messrs. Willans & Robinson, is credited to the Allis-Chalmers Co., although in a full-page sectional drawing of a turbine by the latter company the ordinary system of dummies is illustrated. The method of shrouding blades first adopted by Messrs. Willans is described in connection with the Allis-Chalmers machine, and the Westinghouse method of lacing blades is also described, but there is not a word about the rosary system of blading or the practice of thinning the blade tips, both of outstanding importance in reaction turbine practice.

The Curtis turbine is given 14 pages, and from these one would gather that the old vertical type was still characteristic of this make. The treatment of the Rateau turbine is still more unfortunate. The old dished wheels, with stamped sheet-iron blades riveted to the rims, are illustrated and described as exemplifying current practice, although they have been abandoned for years. After stating that the Rateau turbine possesses from 20 to 40 stages, the author illustrates one with seven stages only. The Zoelly turbine gets only a page and a half of descriptive matter, with no illustrations. The remainder of this thoroughly unsatisfactory portion of the book deals with the Hamilton-Holzwarth and the Wilkinson (Rateau) types, and also describes a few small machines such as the Sturtevant, Kerr, Terry, Dake, &c. The Ljungström turbine, with its extraordinary efficiency and great mechanical interest, is never even mentioned, either in this chapter or elsewhere.

Mixed-pressure turbines and low-pressure turbines to work in conjunction with reciprocating engines form the subjects of two descriptive chapters, and marine turbines are disposed of in a single chapter of seven pages, of which half a page only is given to the possibilities of electrical transmission. The rest of the chapter deals principally with the possibilities of the Westinghouse-McAlpine gear, and of the combination of reciprocating engines and turbines for ship propulsion. It contains no suggestion of knowledge that the latter combination is in actual use, nor that Sir C. A. Parsons's geared turbines have been driving ships for several years.

The chapters on "Tests of Steam Turbines" and "Steam Turbine Economics" call for little comment. In the first, numerous test results are given, but many are quite out of date, and none is later than 1911. After these we come upon a chapter which is quite useful to the designer, giving, as it does, practical methods of calculating the approximate stresses in drums, disks, and rings. The mathematics here, as elsewhere in the book, are well within the average draughtsman's reach, and practical examples are worked out.

The gas turbine is given a chapter to itself, containing views and photographs of some of the few machines which have been designed or constructed, and indicating generally the calculations appropriate to the subject. The author appears to have some hope that in the future a practical gas-turbine may be evolved. He is, however, under no illusions as to the mechanical difficulties incidental to the temperatures employed, and touches, though perhaps too lightly, upon what appears to be the first problem to be solved, namely, the production of an efficient rotary compressor. To get any reasonable efficiency the gas must be compressed before combustion, and until a rotary compressor of at least 80 per cent. efficiency can be constructed, there can never be a commer-

cial gas turbine, however well the temperature difficulties may be surmounted.

Turbo-generators form the subject of the last chapter in the book, and are disposed of in four and a half pages. As may be gathered, the treatment is of the most general kind, and little else is attempted beyond pointing out the limitations encountered when endeavouring to construct generators for high rotational speeds.

Mechanical Handling of Material and its National Importance During and After War. By George Frederick Zimmer, A.M.Inst.C.E. London: Crosby Lockwood & Son. Price 10s. 6d. net. Pp. 140; 144 figs. (10 col. plates.)

This book may be termed a supplementary volume of the author's well-known book, "The Mechanical Handling and Storage of Material," and deals in a concise way with the various types of labour-saving appliances, describing also the improvements that have been introduced since the publication of the larger work.

The subject is of great importance even in peace-time, but vastly more so now that we are in the midst of a dreadful war, and the demand for labour-saving appliances has become so pressing. It will be so even after the war, when the terrible great work of reconstruction begins to repair the terrible ravages of war. We are told that in ordinary times an employer is justified in expending £1,000 capital to save the labour of one man, but after the war there will be such a scarcity of labour that there is every probability that even if twice this amount be required for the machinery to be installed, it will prove to be quite a good investment. In the author's opinion, however, "in practice, if driving power, supervision, lubrication, interest on capital outlay, depreciation, and repairs are taken into account, an outlay of approximately £*100* per man replaced appears to be well within the province of a commercial transaction; but there is not even the necessity for such a capital outlay to save the labour of one man, as such an amount spent is more likely to release five or six labourers."

Practical examples of the various systems of handling material by conveyors, hoists, pneumatic handling, mono-rails, and telpherage are given, in many cases with notes of the cost and saving to be effected. A good part of the work deals with the equipment of gas works, boiler houses, storage of coal, floating loading devices, and bunkering at sea. The subject is, of course, enormous in its range, and the author has done his best to cover practically instances of labour-saving appliances applicable to every industry. The only one that appears to be neglected, but one which is of vital importance at the present time, is labour-saving machinery appertaining to agriculture. The section dealing with portable loading and unloading devices, however, may be read with advantage even by the farmer.

It is a book which at the present time should be carefully studied by the management of every industry, and if there is any means by which labour may be saved the plant or machinery should be installed with the least possible delay; for every penny so invested, pounds will be returned in the years to come.

Telegraph Practice. By John Lee, M.A., Postmaster of Belfast, and late Deputy Chief Inspector of Telegraph and Telephone Traffic, G.P.O., London. Longmans, Green and Co. 2s. 6d. net. Pp. x + 102.

In this small volume of 100 pages Mr. Lee outlines the telegraph practice of this country as it is to-day, and contrasts it with the methods of other administrations.

Coming from one who has in no small measure been identified with the recent developments on the traffic side of telegraphy and telephony, the book may be taken as an authoritative review, not only of the considerations which have determined departmental policy in the past, but also of the probable lines along which that policy may be expected to develop in the future.

In 10 chapters the author deals with such aspects of the subject as the acceptance of telegrams from the public, the centralisation of traffic, instrument rooms, instruments, delivery of telegrams, Press telegrams, tariffs, and the future of telegraph practice.

To-day, when the Baudot system bulks so largely in British telegraph practice, it is amusing to recall Mr. (afterwards Sir) W. H. Preece's assurance in 1882 that this system was not a successful one, and that the "game was not worth the candle"!

Our great underground telegraph system of to-day was likewise regarded by the same high authority then as impracticable, chiefly because it would cost £20,000,000. Let us hope Mr. Lee's anticipations will not suffer a similar fate.

The book, which is packed full of information, is clearly and tersely written, and will, we are sure, be read with much interest not only by those immediately concerned in telegraphic developments, but by that larger number who like to keep themselves *au courant* with national progress generally.—A. F.

NOTES ON THE MINERAL OUTPUT OF GREAT BRITAIN.

The report of H.M. Chief Inspector of Mines for the year 1916 has just recently been issued. This report summarises all particulars from the six inspection districts comprising Great Britain. It takes the place of the separate reports which each District Inspector usually sent in, and therefore is very considerably curtailed.

For the year 1916 we learn that the output of coal was 256,375,366 tons, which is an increase of 3,169,285 tons over the year 1915. The value of the output was £200,014,626, being no less than £42,183,956 greater than for the preceding year. This is due not only to the increased output, but also to the higher selling price, the average for 1915 being 12s. 5·6d., whereas in 1916 the price was 15s. 7·24d. per ton.

The total value of all the minerals raised in this country in 1916 was £214,034,524, being an increase of £43,576,266 over the year 1915. From this it is interesting to note how great and valuable an asset the country has in its coal fields, and how necessary it is to conserve them as much as possible.

The quantity of coal exported was 55,001,113, as against 59,951,925 tons in 1915. The amount of coal remaining for home consumption, therefore, was 201,374,253 tons, or 4·525 tons per head of the population. Of this, however, 39,384,879 tons was used in the manufacture of gas coke and briquettes, and 19,780,690 tons in the manufacture of pig iron, as against 37,173,489 tons, and 18,754,028 tons respectively in the previous year. Summarising the foregoing, we have :—

Coal exported	55,001,113 tons.
Used for gas coke and briquettes ...	39,384,879 ,,
Used in the manufacture of pig-iron	19,780,690 ,,
Domestic purposes	142,208,684 ,,
Total output	256,375,366 tons.

The quantity of anthracite (included in the foregoing totals), raised mostly in the South Wales coalfield, was 4,644,045 tons, the value of which was £4,159,953. Outside the steam coal collieries the price varied from 13s. to 16s., while the steam coal obtained from 16s. to 19s. per ton. The other principal minerals of value are :—

	Tons.	Value.
Chalk	12,786,321	£145,504
Clay and shale	6,500,388	1,247,338
Gold ore	1,338	650
Copper ore	787	6,234
Iron ore	13,494,658	5,545,072
Lead ore	17,107	339,169
Limestone	11,115,909	1,395,830
Oil shale	3,009,232	1,032,294
Salt	1,960,448	904,133
Tin ore	7,892	712,142
Tungsten ores	394	49,699
Uranium ore	51	1,001
Zinc ore	8,476	65,304

Of these some show an increase in output over the previous year, whilst others show a decline. Iron ore, for instance, is less by nearly 800,000 tons, copper is increased by over 200 tons, gold ore is reduced by nearly 400 tons, zinc ore is also reduced by nearly a like amount, whilst tungsten is slightly increased. With the rare metals, however, this is more probably due to natural causes than to any effect in working the deposits due to the war.

The following table is also of interest, inasmuch as it gives the quantity and value of the metals obtained by smelting from the ores given above :—

Antimony ...	4 tons	£340
Copper	278 tons	37,794
Gold (bar) ...	273 oz.	884
Iron	4,319,096 tons	35,045,211
Lead	12,573 tons	389,449
Silver	86 485 oz.	11,284
Tin	4,697 tons	855,656
Zinc	3,000 tons	205,350

The total value was £36,545,968, an increase of nearly £9,000,000 over the year 1915.

With regard to the number of persons employed in the mines of the United Kingdom, there was an increase of 44,045 persons over the year 1915, the total in 1916 being 1,017,518. Of these 804, 69 persons were employed underground and 212,749 above ground. Of the latter 9,947 were females, being an increase of 2,286 females. On the other hand, in the metalliferous mines and quarries there was a decrease in the number of persons employed to the extent of 13,931, the total number being 48,196.

The output per person employed in coal mines, which is approximately 252 tons per annum, is, we regret to say, still very low, and unless there is a distinct improvement in this direction, we may not look to the coal trade of this country for any material help in restoring the national prosperity at the end of the war. We fear that Bolshevism amongst the miners is a factor which will have to be dealt with sooner or later if this country is to maintain its high position amongst the nations of the world.

CORRESPONDENCE.

Letters received by us after 5 P.M. on Tuesday cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

"Prof. Perry's" (?) Harmonic Analysis.

When an English student has made and explained a useful discovery, he seldom gets anything more than the honour of having done so, and one, therefore, cannot too strongly denounce a conspiracy to rob him of this, such as now appears to exist in the case of Mr. Wedmore and his method of harmonic analysis.

This method is explained in the *Proceedings* of the Institution of Electrical Engineers for 1896; and as Prof. Perry had previously invented a method of effecting the same object, he can be excused for not at first having fully recognised the superiority of the new method. But he cannot be excused for having eventually adopted this method in a way that makes it appear to be his own. I have before me a work on "Practical Mathematics," by Usherwood and Trimble, published by Macmillan in 1916, with a section devoted to the explanation of Mr. Wedmore's method, but it is headed "Perry's Tabular Method," and there is no mention whatever of Mr. Wedmore. Mr. Trimble may be genuinely under the impression that the method really is Prof. Perry's; anyone might think so from the way in which Prof. Perry is now teaching it. But I regret to say that this cannot be the case with Mr. Usherwood, for I have now seen a pamphlet written by him, and published by the Board of Education in 1912, which shows that he even then knew this was "Wedmore's method."

Messrs. Macmillan refuse to discuss the matter, and it therefore appears that a great injustice is going to be done to Mr. Wedmore unless some fair-minded editor of a widely-read journal will allow the matter to be dealt with in his columns.

W. F. Dunton.

Newcastle-on-Tyne, *March 23rd*, 1918.

Nomenclature.

After reading Mr. A. P. Trotter's article, I would like to relate my experience in support of "Direct Current." In deciding the nomenclature applied to things in general, one often follows the lead until such time as experience defines more particularly an apt application which may differ from custom.

A case in point occurred with me a few years ago. In regard to electrical matters it had been my custom to follow the diction of Dr. Silvanus P. Thompson at Finsbury, and style the distinctive currents as alternating current and continuous current. I was quite happy in the use of the term continuous current for a number of years, but received a distinct awakening when in competition with an alternating-current man. It will be remembered I was consulting engineer to the Stourbridge Council, and designed the power station and a continuous-current supply system for the town.

During negotiations between the Midland Electric Corporation and the Council, Mr. Hardie McLean very ably informed the Council that if the choice was for continuous current, his company could undertake to give *a continuous supply* for 24 hours per day. Needless to say, the M.E.C. is alternating; so that since that meeting I have preferred to use the prefixes alternating and direct, as either, in public supply, is continuous.

J. B. Clarke, A.M.I.E.E.

Handsworth, *March 23rd*, 1918.

The C.T.A.A. and the E.P.E.A.

In your issue of 21st inst., it is reported that "an application" has been made by the C.T.A.A. to the E.P.E.A. for affiliation. As a member of the former Association, I would point out that the statement is incorrect.

What actually happened was that some members of the C.T.A.A. discussed the matter with members of the E.P.E.A., and it was mutually agreed that as the two Associations had some objects in common, expense and time would be saved if each Association confined its activities to the grades of officers it originally set out to organise, instead of both associations covering the same ground. This, it will be agreed, showed reasonableness on the part of the C.T.A.A., and the majority of the members of the E.P.E.A. with whom the matter was discussed were equally reasonable.

It now, however, appears that there are other interests in the E.P.E.A., which have resulted in the unreasonable attitude adopted, and which should be suppressed if we are to achieve what both associations are setting out for, viz., the formation of a comprehensive association for the protection of the interests of the whole of the electricity supply engineers in the United Kingdom.

H. F. J. Thompson,
Chairman.
Chief Technical Assistants' Association.

Electricity Works, Battersea, *March 22nd*, 1918.

National Electricity Supply.

May I draw your attention to one error in your otherwise excellent abstract of the remarks that I made at the Engineers' Club, Manchester, on the electric power supply of Great Britain.

I am reported to have said that "it was essential that they should have the same type of Board for every district." As a matter of fact, I expressed an entirely opposite opinion, as the subsequent text shows.

S. L. Pearce,
Chief Engineer and Manager.

Electricity Works, Manchester, *March 23rd*, 1918.

WAR ITEMS.

Exports to China.—The "London Gazette" for March 22nd contains a further list of bodies to whom exports to China may be consigned.

Trading with the Enemy.—The "London Gazette" for March 22nd contains further lists of persons and bodies in the following countries with whom trading is prohibited:—Paraguay, Bolivia, Brazil, Chile, Santo Domingo, and Peru.

The Genoa Treason Charge.—The "Times" correspondent at Milan stated that the trial was to begin in Genoa on March 20th of seven Germans and several Italians on a charge of treason in connection with the Genoa Electric Light Works. This company, it is asserted, was used by Germany for many years for purposes of espionage.

Exemption Applications.—At Southport, a motorman on the Birkdale tramways, aged 38, and in Grade 3, was refused exemption, and directed to report for service by April 14th; and an electric car driver, with the Southport Corporation (18, Grade 1) was directed to join up by April 7th.

At Winchester, the National Service Representative appealed against exemption held by a meter tester and a stoker at the Corporation electricity works. In the former case it was contended that the man was not employed in generating electricity, but a representative from the department said that it would not be possible to maintain the supply of current in the city if the man was taken. It transpired that he was in Grade 3, and, as the case was not pressed, the Tribunal dismissed the appeal, holding that the man was in a certified occupation. In the case of the stoker (Class A), the Military contended that the case was one for substitution by the employers. On the other hand, it was urged that the occupation of a stoker was a skilled one, as it involved the management of the boilers, the man being responsible for the maintenance of the head of steam. It was added that there were three stokers at the works, each working an eight-hour shift. This appeal was also disallowed on the ground that the man is in a certified occupation.

At Maidstone, on March 18th, appeals were filed for the retention of W. H. Brown (38) and E. Wicks (28), engaged by Mr. Oswald Jones, electrical engineer. It transpired that both men had received protection cards, and no action was consequently taken.

At Worcester Tribunal, Lieutenant C. E. Abell, electrical engineer, Worcester, asked for the renewal of the certificate granted to W. Tetstall (42), who is carrying on the business whilst the employer is in the Army. It was stated that the man was doing important work, including the supervision of seven rifle-range telephones. The certificate was renewed until June 30th.

At Reigate, exemption was claimed for L. L. Cochrane (35), electrical engineer at Netherne Asylum. It was stated that

he helped to carry out the installation, and that he knew the whole of the wiring at the asylum. Temporary exemption until June 15th was granted.

At Oxford, the Electric Tramways Co. appealed for further exemption for T. Smalley (33, B 1) and V. Hill (36, B 1), foremen drivers. The general manager, Mr. A. A. Tyler, said that they had been unable to replace the men, and women were unsuitable for the work. Each was given two months' temporary exemption.

BUSINESS NOTES.

Dick, Kerr Developments.—As our readers are already aware, Messrs. Dick, Kerr & Co., Ltd., who many years ago established a world-wide reputation as contractors for tramway, railway and other big public works, and followed on with the manufacture of electrical machinery at Preston, made arrangements a few months ago for the acquisition of the United Electric Car Co., Ltd., Preston, where railway and tramway rolling-stock had long been a speciality. They had also acquired control of the business of Willans & Robinson, Ltd., of Rugby, the well-known builders of engines, turbines and Diesel engines. The foregoing businesses, while retaining their separate identities, are concentrated for sales purposes, as already explained, in the hands of Messrs. Dick, Kerr and Co., Ltd., whose headquarters are at Abchurch Yard, Cannon Street, E.C. We now learn that within the last few weeks negotiations have been completed with the Phœnix Dynamo Manufacturing Co., Ltd., of Bradford, by which certain standard types of electrical machinery, which have been manufactured separately by both companies, will be manufactured jointly at Bradford. The advantages accruing from such arrangements, especially from the combination of the technical and manufacturing experience of the various firms which they thus ensure, though each of the works will confine itself to those products for which it is best equipped, hardly need pointing out. Under the centralised direction of the D.K. organisation, with its extensive Home and foreign connections at the service of the associated companies, the combination should find itself well prepared to meet after-war competition.

Lists.—Messrs. W. T. Henley's Telegraph Works Co., Ltd., Blomfield Street, London Wall, London, E.C.—Net price booklet relating to taped and braided wires and cables, and the Henley wiring system. This is the third edition. Copies will be sent to any *bonâ fide* buyer who has not already received one.

Messrs. Belling & Co., Edmonton, London, N. 18.—Illustrated circular giving a few particulars of their electric roasting and baking ovens for communal kitchens.

Liquidations.—Monometer Manufacturing Co., Ltd.—This company is winding up voluntarily. See this column last week.

Galway and Salthill Tramway Co.—Mr. M. Crowley has been appointed by the Courts official liquidator for winding up this company.

For Sale.—Middleton Corporation Electricity Department invites offer for surplus electrical plant consisting of steam dynamos, boilers, and accumulators. Particulars are given in our advertisement pages to-day.

Trade Announcements.—Owing to the Government having taken possession of their offices at the White Mansion, York Street, Westminster, Messrs. J. B. Saunders & Co., Ltd., have removed (as from 28th inst.) to Cromwell House, 6-9, Surrey Street, Strand, W.C. 2.

Messrs. Handley & Robinson, Ltd., electrical contractors, who are moving from Great Charles Street to 165, Edmund Street, Birmingham, desire to receive catalogues and price lists from manufacturers of electrical goods.

Bankruptcy Proceedings.—G. E. Hipkins, electrical engineer, Bath Street, Dudley.—Supplemental dividend of 5s. 1½d. in the £, payable March 25th, at Official Receiver's office, 1, Priory Street, Dudley.

No Dry Batteries from Norway.—The Norwegian Government has prohibited the exportation of dry batteries of all kinds during the war.

LIGHTING AND POWER NOTES.

Aylesbury.—Price Increase.—The T.C. has revised the tariff as under:—Private dwellings, for lighting, 7d. and 1½d. per unit; shops, for lighting, 4d. per unit; power, 3d. for the first 250 units per quarter, decreasing on a sliding scale to 1½d. for all above 2,250. For the summer quarters the minimum is fixed at 6s., and for the winter quarters at 10s.

Bridlington.—At a recent meeting of the T.C. reference was made to a scheme for the development of a considerable portion of the East Riding district. If carried out, it would open out the important agricultural district across the Wolds, extending approximately from Flambro' to Frodingham Canal, in the direction of Hornsea. Electrical energy would be generated at Bridlington and transmitted through the district, supplying farms and villages with electricity for power and other purposes. It is estimated that the scheme would involve an expenditure of £250,000.—*Sheffield Independent.*

Brighouse.—Wages.—In response to the Corporation workers' demand, through the Workers' Union, for £1 per week advance on pre-war wages, plus 12½ per cent. bonus on total earnings, the Committee on Production has awarded, as from the first pay day in January, 1918, 8d. per shift advance to shift workers over 18 years of age, and 4s. per ordinary week to other workers. The previous increases have been 12s. to 16s. per week. There is no mention in the award of the 12½ per cent. bonus.

China.—H.M. Consul-General reports in the *B. of T. Journal* that there is a very promising business to be done in irrigation plant in Yunnan, where there are prospects of a great future for British trade. At present, within a few hours' journey of the city of Yunnanfu, there are in operation four irrigation sets owned by a private company. It would be comparatively easy to install a hundred such sets if the business were followed up and cared for, as there are immense tracts of land within easy reach of water, but at an elevation of some 15 ft. above the water level. When the owners can be made to see that the installation of pumping sets is advantageous, and that water can readily be lifted and supplied to the fields at very cheap rates, business will go ahead. It is very important that the farmers should be favourably impressed, and the machinery, therefore, should be of first-class workmanship; the makers should supervise the installation and attend to the many details that tend to make a plant like this a success.

Clayton.—Prov. Order.—The Electrical Distribution of Yorkshire, Ltd., has intimated its intention of withdrawing its application for a provisional order for supplying electricity to Clayton.

Frinton-on-Sea.—Price Increase.—The E.L. Co. has informed the U.D.C. that it intends applying to the B. of T. for sanction to raise the maximum charge for energy from 7d. to 9d. per unit. The Council has decided to ask the B. of T. to limit the increase to the period of the war, and for not more than six months afterwards.

Huddersfield.—Rates Relief.—At a meeting of the T.C., last week, when rating was considered, it was stated by Alderman Woodhead (chairman of the Finance Committee) that notwithstanding the heavy cost of repairs and of war bonuses, the Tramways Committee could afford to grant 3d. in relief of the rates (as compared with 4d. last year) and the Electricity Committee would give 1d. in the £ in relief.

Hull.—The Corporation Electricity Committee has appointed the chairman (Councillor Pybus) and the acting electrical engineer (Mr. Magoris) to interview the Ministry of Munitions with respect to the difficulty of efficiently maintaining the generating station owing to the calling-up of employés. It was reported at the last meeting that the last of the switchboard attendants and a charge engineer had been called up.

London.—Hampstead.—Price Increase.—The Lighting Committee has considered the question of the estimated deficiency of £3,970 at March 31st, 1919, and recommends that the war charge should be increased as from the readings of the meters in September next from 33⅓ per cent. to 50 per cent.

St. Pancras.—Rate Relief.—The Finance Committee reports that a balance of £6,114 remains after the retention of £4,000 as a working balance, to the credit of the electricity revenue account to March 31st, 1917, and recommends that £6,000 should be allocated to the relief of rates.

Stepney.—The General Purposes Committee reports for the information of the Council that the Electricity Supply Committee has informed it that the extension of the expression "munition work" in the Munitions of War Act, 1915, by the Munitions of War (Amendment) Act, 1916, covers the electricity supply undertaking, whilst Sec. 12 of the last-mentioned enactment explains the term "workman" and "workmen" wherever they occur in both enactments as including "not only persons whose usual occupation consists in manual labour, but also foremen, clerks, typists, draughtsmen, and other persons whose usual occupations consist wholly or mainly in work other than manual labour"; and that the officials of the undertaking, including the electrical engineer and manager, are, therefore, automatically entitled to, and consequently participate with the technical staff and other employés in, the benefits of the awards of the Committee on Production and receive a war wage advance of £1 per week on pre-war rates, in addition to an amount equivalent to 12½ per cent. on their total earnings, including such advance.

Manchester.—Fire.—A serious fire at the sub-station of the British Carbide Factories, Ltd., Clayton, which is supplied with electricity from the Stuart Street generating station, involved the whole of the company's electrical apparatus. A severe short circuit reduced the high-tension voltage to such an extent as to throw out of action practically all the plant in the sub-stations supplying the tramways. Some portions of the general system were not affected. There was no accident at Stuart Street, and no damage to the plant installed there.

Oakengates.—Power Bill.—The U.D.C. has decided to oppose the Bill of the Shropshire, Worcestershire, and Staffordshire Electric Power Co.

Oxford.—Price Increase.—The Oxford Electric Co., Ltd., has revised the prices of energy as under after the reading of the meters for the March quarter:—Lighting, up to 20 units per quarter, a minimum of 13s. 4d.; for the next 180 units, 5½d. per unit; the next 500, 5d.; the next 1,000, 4½d.; the next 3,000, 3½d.; beyond, 2½d. Heating and cooking, 1½d. Motive power, up to 2,000 units per quarter, 1½d.; the next 3,000, 1½d.; the next 5,000, 1½d.; beyond, 1d. These rates, except the statutory rate of 13s. 4d., are subject to a temporary increase of 25 per cent.

Stoke-on-Trent. — Price Increase. — The T.C. has increased the price of energy by a further 20 per cent., a total advance of 60 per cent.

Swanage.—Price Increase.—The Electric Supply Co. has informed the U.D.C. of its intention to apply to the B. of T. for authority to raise the price of energy to 10d. per unit. The Council has decided to ascertain the existing rates in other towns, and if these are the same, no action will be taken in the matter.

TRAMWAY AND RAILWAY NOTES.

Birmingham.—Wages.—Last week the 12½ per cent. bonus was granted to the Corporation employés in the gas and water departments and to the men engaged on the permanent way and at the tramway depôts. The Committee on Production orginally reserved its decision with regard to the traffic employés, and finally placed the responsibility on the Corporation. The motormen and conductresses decided to cease work, as from last Saturday night, if the award were not granted. A Conference, presided over by the Lord Mayor, was held at the Council House, on Saturday, and it was agreed that it was impossible to differentiate between the shed and permanent-way men and the traffic staff. The 12½ per cent. bonus, as from December 15th, was granted to the motormen, and 3s. 6d. per week to women over 18, and 1s. 9d. to those under 18.

Blackburn.—Strike Notice.—The secretary of the Amalgamated Association of Tramway Workers notified Mr. Cowell (tramway manager), on behalf of the members of the branch, of their intention to withdraw their labour on March 28th. The questions in dispute are the alleged improper payment of the recent awards by the Committee on Production and the alleged dismissal of a driver for refusing to teach driving to any other persons than discharged sailors and soldiers.

Bradford.—Wages.—After four days' idleness the Bradford cars resumed service on Wednesday last week, the Committee on Production having agreed to adjudicate as to the interpretation to be placed on the recent national award of £1 per week above pre-war rates of pay, with regard to the women employés of the tramway undertaking. The Bradford women are paid at the same rate of wage as the men conductors, but receive a lower war bonus, and the Tramways Committee, therefore, contended that they were not included amongst the women to receive the £1 award—a contention which was upheld by inquiry of the Committee on Production. Representatives of the two parties met and signed an agreement to use their best endeavours to prevent a repetition of the strike, and for that purpose they will meet in conference if and when any dispute arises, and will take any other steps which will tend to an amicable settlement, it being the declared wish of both parties that such differences shall be settled in a constitutional manner. The matter was to be heard by the Committee on Production on Thursday of this week.

Doncaster.—Strike.—The municipal workers' strike is continuing, and forced the stoppage of the cars on Tuesday last week, owing to workers in the sheds and in the electricity department being concerned in the dispute, though the bulk of the tramway employés were content with the recent national award. The electricity service has been maintained. The cause of the strike is a demand for a further increase of 8s. per week for men and 4s. for youths.

Edinburgh.—In view of the tramways being taken over by the Corporation next year, a Sub-Committee of the Tramway Committee recommends that a manager of the undertaking should be appointed.

Leeds.—Wages.—The Committee on Production is being consulted on the position of the women who do not yet receive a bonus, owing to their not having completed three months' service.

An early result of the increased bonus to tramway employés is expected to be an advance in fares. In January the tramway manager (Mr. J. B. Hamilton) prepared an estimate of the result of the year's working; but, in view of the recent wage advance and increased cost of materials, he has been requested to prepare a further report, which will be made in the light of the receipts of the undertaking up to the end of the financial year, which is getting near. About Easter new stopping and starting arrangements in the centre of the city will come into operation, to avoid the present congestion. The queue system will be extended.

Nottingham.—The T.C. has applied to the B. of T. for a further extension of time until August 15th, 1919, for the completion of work in connection with the tramways from Beeston to Nottingham.

Parcel Service.—In the House of Commons on Wednesday, March 20th, Mr. Wardle informed Mr. Gilbert that tramway undertakings had power, generally speaking, to carry parcel traffic. The attention of tramway authorities had been called to this point, and he was inviting the Tramways Committee of the Board of Trade to consider it.—*Evening News.*

Railway Workers' Wages.—According to the *Evening News*, the Underground Railway workers' wages dispute has been settled in favour of the men. The question, which was referred to the Committee on Production, was whether the overtime payment of Sunday work granted by railway companies to members of the two Unions engaged on Sunday shift in the generating and power stations of the railways should, or should not, be merged in the 12½ per cent. bonus. The Committee has decided that the extra payment for such work should not be merged in the bonus. The decision will mean an addition of about 4s. a week to the men's earnings.

Mr. J. H. Thomas, M.P., has been instructed by the Executive Committee of the National Union of Railwaymen to apply for a review of the existing wages agreements with a view to an increase, in the light of the altered circumstances, the decision to become operative as from March 31st. A demand that all women shall be paid the same war wages as those paid to men has also been decided on.

The Electrical Railway Workers' Committee has, at the same time, presented a further demand for an advance of 10s. per week.

Salford.—Increased Fares.—The Corporation Tramways Committee has decided to increase the fares, and the matter has been referred to a Sub-Committee. The new scale will probably come into operation in about six weeks' time. The recent further war bonus to motormen and conductors means an added increase of over £20,000 a year.

Tramcar Drivers.—The Home Secretary has decided to grant certificates to discharged soldiers to act as tramcar drivers on the Metropolitan Tramways at the age of 19.—*Pall Mall Gazette.*

TELEGRAPH AND TELEPHONE NOTES.

The Lag in Wireless Time Signals.—Some experiments were recently conducted by F. D. Orie, of the United States Naval Observatory, on the lag in wireless time signals between Arlington and Great Lakes Station. The lag was found to be approximately 0·085 second, with a probable error of 0·002 second.—*Scientific American.*

South Africa.—A European has been sent to prison for three months without the option of a fine for using insulting language to an operator at the Johannesburg Central Telephone Exchange.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdare.—March 31st. Electricity and Tramways Department. Stores for 12 months. See "Official Notices" February 22nd.

Aberdeen.—April 9th. Electricity Department. One 5,000-kw. turbo-alternator, surface condenser, and auxiliaries. See "Official Notices" March 22nd.

Australia.—Melbourne.—June 7th. Department of the Navy. Supply and erection of power plant at Garden Island, Sydney. Director of Navy Contracts, Melbourne.

Darlington. — March 29th. Electricity Committee. Water-tube boiler, economiser, cooling tower, fan, and feed pump. See "Official Notices" March 15th.

Edinburgh. — March 30th. Electric fittings, &c., for Midlothian and Peebles District Asylum, Rosslynlee. Clerk and Treasurer, 19, Heriot Row, Edinburgh.

Manchester.—April 2nd. Corporation Electricity Committee. For Moss Side sub-station. Three 3,000-k.v.a., 33,000-volt, three-phase, static transformers. Specifications, &c., from Mr. F. E. Hughes, Electricity Department, Town Hall.

Middleton.—April 8th. Electricity Committee. Two 500-kw. motor converters and e.h.t. switchgear. See "Official Notices" to-day.

Spenborough.—April 10th. District Council. Works required for extensions at electricity works. Engineer, Mr. A. Rothera, M.I.M.C.E., Town Hall. (Plans three guineas for complete set of quantities, or one guinea for separate trades, returnable.)

CLOSED.

Southend.—T.C. Two 2-ton electric wagons. Messrs. Ransome, Sims & Jefferies, Ltd. Total cost £2,067. The Tramways Committee has accepted the tender of Messrs. Edgar Allen & Co., Ltd., for six tramway tongues, at £7 15s. each.

Stepney.—Electricity Committee.

E. Foster & Co.—1,000 tons nutty slack, 24s. 7d. ton. 3,000 tons West Cannock D.S. nuts, 28s. 4d. ton. 2,000 do. 2 in. nutty slack, 22s. 10d. ton.
Bradbury & Co.—150 tons Pooley Hall slack, 21s. 10d. ton.

NOTES.

The Marconi Case.—In reply to Sir Charles Hobhouse's letter, mentioned in our last issue, Mr. Godfrey Isaacs wrote to him as follows :—

Sir,—I have received your letter of yesterday. Your solicitors requested the company's solicitors to excuse your attendance, as they presumed it would be unnecessary to call you as a witness. The company's solicitors replied that they could not do so, but that, provided you attended on the first day of the hearing, they would study your convenience as far as possible with regard to your subsequent attendance. Presumably it was because this was not satisfactory to you that you then took the unusual course of writing to the learned Judge.

1. You have for three years refrained from testing the accuracy of the statements of which you now complain.

2. You have failed to take advantage of the opportunity recently given to you to go into the witness-box and submit yourself to cross-examination.

3. You have adopted the "safe" course of availing yourself of the protection afforded to you by the House of Commons, where your statements could not be tested, and of attacking me there, where my hands are tied; and

4. When I invite you to come into the open, so that your veracity and honour and mine may be put to the test in open Court, you refuse to do so.

It is, as you say, for the public to draw their own inference, and I confidently invite them to do so.—Yours truly,

GODFREY C. ISAACS.

Marconi House, Strand, W.C. 2, March 21st.

The following letter was sent by Sir Charles Hobhouse to Mr. Godfrey Isaacs on March 22nd :—

Sir,—I have received your letter of yesterday's date. I was subpœnaed only to produce certain documents, and my solicitors wrote stating that I had not, and never had had, any such documents.

They suggested, therefore, that it would be unnecessary for me to attend the Court for that purpose, but asked, if my attendance was still required, for some explanation as to why it was required. They did not request the company's solicitors to excuse my attendance.

You assert that I am sheltering myself behind the privileges of the House of Commons. The attack made upon me through the counsel for the Marconi Co. is, I am advised, and you must be aware, also privileged. In order to give you every opportunity of testing the accuracy of our respective statements, if you so desire, I hereby state :—

(*a*) That the allegations contained in the letter which you say you received from the Telefunken Co., so far as they concern myself, are false.

(*b*) That the account which you gave in a letter to Lord Gainford of June 29th, 1916, of a private interview between us on February 6th, 1915, is in many respects wholly untrue, and in others misleading. For instance :—

1. Your statement that I made an offer to the Telefunken Co. is untrue.

2. Your statement that I recognised that, as a Minister of the Crown, I should not have made this offer is untrue.

3. Your statement that I asked you : "What it was your intention to do," and that I said : "You had your foot on my neck; did you intend to crush me, which would mean my leaving the Government, or were you disposed to help me?" is untrue.

4. The whole of the following statement :—

"I told him that I had no desire to make use of the letter unless I was compelled to do so, and that if any settlement of the Imperial Contract matter could be arrived at, which I would do everything in my power to assist, there would be no reason whatsoever for the letter ever being disclosed. He thanked me sincerely for this assurance," is untrue. Yours faithfully,

C. HOBHOUSE.

At the instance of Mr. Godfrey Isaacs a writ was issued against Sir Charles Hobhouse for libel on Monday last.

Supply Engineers' Salaries.—A report of the Lighting Committee of the Barnes U.D.C. states that it considered a draft resolution which was submitted to the Conference of local authorities owning electrical undertakings in Greater London on the question of the salaries of chief engineers, but decided to take no action, as it was of opinion that the Conference should not interfere with the question of the engineer's salary so far as that district was concerned.

Volunteer Notes.—LONDON ARMY TROOPS COMPANIES, VOLUNTEER ENGINEERS.—Headquarters: Balderton Street, Grosvenor Square, W. 1.

Orders for the week ending April 6th, 1918, by Lieut.-Colonel C. B. Clay, V.D., Commanding.

Captain of the Week.—Capt. W. Hynam.
Next for Duty.—Capt. W. Darley Bentley.

Monday, April 1st.—Commandant's Parade at Waterloo Station, 8.45 a.m. for inspection at Esher. Marching order, with rifles. Mid-day and tea rations to be carried.

Tuesday, April 2nd.—Lecture on "Demolitions," at 6.30. Physical Drill and Bayonet Fighting at 7.30.

Wednesday, April 3rd.—No. 1 Company, Entrenchments, &c., 6.30—8.30. Recruits' Drill, 6.30.

Thursday, April 4th.—No. 2 Company, Entrenchments, &c., 6—8. Recruits' Drill, 6.30—8.30. Signalling Section, 6.30—8.30. Ambulance Section, 6.30—8.30.

Friday, April 5th.—Musketry, 5.30—6.

Saturday, April 6th.—Musketry, 2.45—4.45. Knotting for the whole Corps, 2.45—4.45.

Special Notice.—On March 31st, all D and B men who have not signed the A and B Agreement will be discharged automatically.

(By order) MACLEOD YEARSLEY, *Capt. and Adjutant.*

The Utilisation of Bavarian Water Powers.—An important step in advance in connection with the utilisation of the large water powers in Bavaria is reported to have just taken place by the formation with the co-operation of the Bavarian Ministry of two syndicates for dealing with the powers of the Upper Inn and the Central Isar repectively, which are the two Bavarian rivers which are still free and which have been reserved for industrial purposes. In the case of the Inn three power sections come under consideration. The central section near Jettenbach is intended for the Imperial aluminium works, which is to be erected after the conclusion of peace, and 50,000 H.P. is to be utilised. The question concerns an expenditure of about £3,000,000. The upper section from Kufstein down to Attal is expected to yield 60,000 H.P., whilst a further 50,000 H.P. is to be obtained between Muhldorf and Simbach. The negotiations which have now been brought to a provisional conclusion concern the Inn above the projected aluminium works.

The Isar from Puppling down to the mouth has already formed the subject of projects and partly been assured to various interests. The uppermost section near Puppling has been reserved for the State Railway Administration. Near Iching a section has been conceded to the Isar works, and the utilisation of a large portion of the power has already been guaranteed by contracts, although this section will only be developed by the Isar works after the war. A scheme for about 70,000 H.P. is contemplated below Moosburg to the Danube by the General Electricity Co., of Berlin, whilst the central section from Munich to Moosburg is interesting the city of Munich for ensuring the latter's supply and also industrial concerns. It seems now to have been possible so to arrange the various schemes that both the needs of the city and of industries can be satisfied, as results from the fact that the Munich City Council has joined the second syndicate which purposes to utilise these sections of the Isar. The most satisfactory consequences of the negotiations are that all interests have been brought together for common action, and thus the competition for concessions which has frequently prevented practical work has been avoided.

The basis of both syndicates is formed by the constituents of the Bavarian Water Power Community, which is composed of the Bavarian Mortgage & Exchange Bank, the Bavarian Verein Bank, the Bavarian Commercial Bank, the Bavarian Discount & Exchange Bank, and the Nuremberg Electricity Co. (late Schuckert). The Water Power Community was formed last June as an investigating commission to take stock of the free water powers still available, to examine as to their utilisation, prepare projects, and induce manufacturers to establish industries and co-operate in the flotation of the requisite capital. The Water Power Community has now been expanded for the execution of the work of opening up the Upper Inn and the Central Isar that is now in hand. In the first place, the raising of the necessary funds will require further assistance, and in this respect the support of the Disconto Gesellschaft, of Berlin, has been obtained, together with that of the banking firm of Freidmann, Bleibtreu & Co., of Berlin, who were already interested in the development of Bavarian water powers through the Leitzach works. Secondly, the technical side has been amplified in the syndicate for the Upper Inn by the accession of the Metal Bank and Metallurgical Co., of Frankfort-on-Main, and the Griesheim-Elektron Chemical Works Co., of Frankfort, and the syndicate for the Central Isar by the inclusion of the Fried. Krupp Co., of Essen, and the same company's gun factory at Munich.

Copper for Electric Wire in Sweden.—The use without licence of copper for the manufacture of certain kinds of electric wire has been prohibited in Sweden by a Royal Decree dated November 9th. The prohibition came into force on December 1st. It is provided in the Decree as follows :—

"For the manufacture of such electric wire, enclosed in an insulating substance, as contains a conducting area of six square millimetres or less, copper shall not be used without a licence from the Executive Committee of the Industrial Commission."

The object of these regulations as officially stated in a Press communiqué is to ensure that copper shall only be used in cases where substitutes are not available, notably in the manufacture of electric machines and transformers. It is also stated in the Press that zinc can conveniently be used as a substitute for copper in indoor wiring; that the supply of zinc in Sweden is abundant; that the manufacture of zinc electric wire has been successfully taken up in Sweden; and that the country's requirements of that material can be provided in the country itself.—*Board of Trade Journal.*

Whitley Committee.—The *Times* states that steps are being taken to form a National Council for the iron and steel trades on the lines of the Whitley report.

Appointments Vacant.—Shift engineer (70s.), for the City of Lincoln Electricity Department; electrician (63s.) for the Portsmouth Corporation Tramways; assistant lecturer in electrical engineering (£175 plus 5s. per hour for evening classes), for the City of Hull Education Committee; engineer-in-charge, also engine-driver, for the Corporation of Tunbridge Wells Electricity Works; shift engineer (£213) for the Edinburgh Corporation Electricity Department; two switchboard and sub-station attendants (50s. to 65s.) for the Salford Corporation electricity department. See "Official Notices" to-day.

Institution and Lecture Notes.—Association of Mining Electrical Engineers.—A joint meeting with the Colliery Managers' Association was held at Stoke, on the 9th inst., when a paper on "The Care and Testing of Colliery Electrical Cables" was read by Mr. A. F. W. Richards.

Institute of Metals.—The report of the Council for the year 1917 shows that war conditions have stimulated the activities of the Institute, and have led to a very large increase in the membership, which has risen from 660 to 888 during the year, a net increase of over 34 per cent. At least 72 members are on active service. The Government grant to the Corrosion Research Committee has been increased from £650 to £1,000 a year; a further grant of £450, with a like sum from the B.E.A.M.A., has been devoted to an investigation into the causes of corrosion of condenser tubes by fresh water, and a Freshwater Corrosion Research Committee has been appointed. The hon. treasurer's report shows an excess of receipts over expenditure of £698, compared with an average of £156 for the four preceding years.

Royal Institution.—Amongst the arrangements for lectures after Easter are the following:—Prof. John Joly, two lectures on "Scientific Signalling and Safety at Sea"; Lieut.-Colonel C. S. Myers, two lectures on "Present-Day Applications of Experimental Psychology."

Institution of Electrical Engineers.—At the meeting on Thursday, last week, before Dr. Barclay's paper was discussed, the president stated that Mr. C. P. Sparks had generously presented to the Institution a portrait of Galileo, which was exhibited in the Lecture Theatre. The thanks of the Institution were cordially awarded to the donor.

A joint meeting of the Institution and the Electrical Section of the Royal Society of Medicine will be held at the Cancer Hospital, Fulham Road, S.W. (between Nos. 177 and 187), on Thursday, April 11th, at 7.30 p.m., when the following papers will be read:—Dr. E. P. Cumberbatch, "Diathermy: the Use of Electricity for Heating the Tissues of the Body in Disease"; Dr. R. Knox, "Single-Flash (Instantaneous) Radiography: Its Possibilities and Limitations." There will also be an exhibition of electro-medical apparatus.

Patents and Trade Marks.—In the *B. of T. Journal* for March 21st a report is given of the speech of the President of the Board in reply to a deputation in connection with the Bill now before Parliament. He pointed out that to extend the duration of patents to compensate the owners for losses due to the war would be to place patentees in the position of a privileged class, who were not to be penalised as the result of the war. That would introduce a contentious element prejudicial to the passage of the Bill. It was imperatively necessary to pass the Bill as soon as possible, and there was no need for a special Bill dealing with the life of patents, as the present Bill could be modified if required. He would do his best to get it through as quickly as possible. He expressed surprise at the opposition to Part 2 of the Trade Marks Bill; their desire was to help the trade interests of the country, and the representations of the deputation would be most carefully considered. The clause was intended to prevent the establishment of a perpetual monopoly of a commodity by the use of a word—a trick which had been practised particularly by the Germans; there was no intention to interfere with the legitimate use of trade marks.

In the same issue of the *Journal* the reports of the Departmental Committees on the Engineering Trades and Shipbuilding and Marine Engineering are quoted at some length on patent and trade-mark questions. The former Committee advocates the harmonising of the laws throughout the Empire, the acceptance of manufacture within the British Empire as complying with any manufacturing clauses in such laws, and the arrangement of similar fees. The clause of the Patents Act requiring manufacture in this country should be more stringently enforced, as by specifying a proportion to be so manufactured as compared with the total import of such articles under patents held abroad, and some competent body should be appointed to decide as to the reasonableness of the royalties and terms demanded for the grant of licences, without reference to the Courts. The onus of proof of manufacture in this country should be thrown upon the patentee. The value of ancillary patents intended to prolong the life of a master patent should be subject to challenge before the Controller, and the life of patents should be made 15 years throughout the Empire. The abuse of the patent laws of this country and Germany by Germans, who secured "blocking patents" here and withheld patents in Germany from British citizens, should be dealt with, and the cost of Empire patents should be reduced. The validity of a trade mark should depend on priority of user, and not upon the date of registration.

The other Committee draws attention to the use of the Courts by wealthy litigants to create monopolies by the employment of procedure through injunction, leading to great injustice both to the individual and to the State.

Fatality.—An inquiry was held at Newcastle-upon-Tyne Infirmary, on March 20th, into the circumstances attending the death of Joseph Irwin Waugh, of Ryton-on-Tyne, who died from burns received at an electrical sub-station on the North-East Coast. It being necessary to inspect and clean some high-pressure bus-bars, to prevent workmen from coming into contact with the live conductors, screens were placed in position. One of these stuck, and while Waugh was pulling it back with an insulated pole there was a flash and an explosion. Waugh was burned practically all over the body, and another electrical engineer was burned about the face and hands. A subsequent examination showed that the screen had been dislodged, and caused a short-circuit. There was no defect in the screen. Verdict: "Death from shock due to burns."

A Stepney Boiler Contract.—According to the Stepney Borough Council Minutes, that body is recommended by the Electricity Committee to take steps in accordance with the opinion of Mr. J. Hunter Gray, respecting a contract with the Howden Boiler Co. for boilers installed at Limehouse station (£35,700). It is proposed that the Council's solicitor should address a communication to the Howden Co., rejecting the plant, and should commence legal proceedings against the company for damages for breach of agreement, &c. The situation arises consequent upon the refusal of the company to undertake the tests provided for by the contract, or to accept the results of the tests carried out between May, 1916, and September, 1916.

Legal.—Electric Furnace Patents.—In the King's Bench Division, on Monday, Mr. Justice Bray was asked to make a declaration that two contracts which Messrs. Grondal, Kjellin & Co., Ltd., iron and pyrites merchants, Abchurch Lane, London, had entered into with Siemens-Halske Aktiengesellschaft, of Berlin, became dissolved upon the outbreak of war.

Mr. Stuart Beavan, counsel for Messrs. Grondal, Kjellin & Co., stated that the matter was before his Lordship in December and January last, and was adjourned to enable the defendants to be represented. He now read correspondence which had since taken place with the agents of the defendants, showing that the latter did not wish to be represented, but that they were anxious that the rights of the American Iron and Steel Manufacturing Co., under an agreement with them dealing with these patents, should not be prejudiced. Defendants were not now represented. Counsel went on to explain that there were two agreements concerned in his application for an order. They related to patents for certain processes in the manufacture of electric furnaces used in the making of high-grade steel. By these agreements rights were given by the plaintiffs to the defendants in regard to certain territory. The territory covered by the first agreement was the United States and Canada. Under Clause 2 of this agreement, Siemens-Halske received the exclusive right to grant licences under the patents in the territory named. Payment was to be at the rate of two-thirds to plaintiffs and one-third to defendants in respect of the patent sales. Defendants were to have the right to cancel the agreement at the end of two years by giving six months' notice in writing, plaintiffs having a similar right, but neither party had exercised this right. Counsel understood that the American company mentioned in the correspondence were licensees under defendants of some of the patents, but if the order asked for were made, their rights would not be affected. The American company derived their rights from licences issued to them before the war. The second agreement was in the same terms, but the territory covered in this case was the British Colonies. His Lordship would see how very seriously the interests of this country would be crippled if no use could be made of these patents in America and the British Colonies during the war. The agreements involved constant communication between the plaintiffs and defendants, and plaintiffs' representative was in Berlin in connection with them when war broke out, and he was arrested, and was still interned.

His Lordship made the declaration asked for.

High-Pressure Test upon Rubber Gloves.—All new gloves received by the Rochester (N.Y.) Railway and Light Co. are tested before they are placed in service, and, in addition, receive occasional tests afterwards. The test is different from the ordinary one, in that 10,000 volts is applied while an ammeter is connected in series with the glove, so that the current passing through the glove can be observed. Tentatively, all gloves are considered unsatisfactory if the current exceeds 10 milliamperes.

One objection which has sometimes been raised to this test is that the glove might be weakened thereby, especially if the test is conducted frequently. To determine whether there was any ground for this objection, an ordinary glove which had been used considerably was subjected to 10,000 volts for 26 hours, at the end of which time it broke down at the surface of the water.

When it is considered that the tests are not liable to be applied more than one minute or one and a half minutes a month, it should be evident that this method of testing is harmless, even if the experiments do not prove it.—C. G. Brown, in the *Electrical World*.

The Electric Gun Again!—The bombardment of Paris by guns of extraordinarily long range has raised a crop of conjectures as to the nature of the weapon, including, of course, the electric gun. Exactly ten years ago (April 3rd, 1908, page 581) we showed, by the most elementary dynamics, that the idea of employing electric power for this purpose was utterly absurd and impracticable. But the lay Press is easily gulled by *soi-disant* "electrical experts."

The Magneto Industry.—The remarkable development of the British magneto industry since the outbreak of war was discussed by the Edinburgh Rotary Club, on Thursday last week, when the speaker was Mr. Peter F. Bennett, of Birmingham. He stated that the capital invested in the British magneto industry was approximately £1,000,000, and without including those engaged in subsidiary trades, it gave employment to 5,000 persons.

Proposed Super-power Station.—The Mersey Power Co. is in negotiation for a site for the erection of one of the super-power generating stations suggested by the Ministry of Reconstruction's Coal Conservation Committee. The directors of the Salt Union have decided to subscribe for another £100,000 of capital in the company, while the Ministry of Munitions has agreed to make a loan of £300,000.—*The Times.*

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station and Tramway Officials.—There were 41 applicants for the post of assistant electrical engineer at Cape Town. From a selected six of these the Electricity Committee recommended, and the Council approved, the appointment of MR. A. G. VAL DAVIS, electrical assistant to the maintenance engineer of the Victoria Falls Power Co.

The L.C.C. Highways Committee recommends a number of promotions in the tramway department. These include:—MR. W. P. FARQUHARSON, general assistant and acting chief clerk, to become chief clerk, and to be advanced from £600 to £800; MR. H. VORLEY, tramway accountant, advanced from £500 to £550, rising to £600; MR. R. E. FARBRIDGE, assistant accountant, to be senior assistant; MR. T. R. IRELAND, assistant in the third class, to become claims superintendent, and to be advanced from £190 to £300; MISS E. HODGE becomes superintendent of women checkers at £250.

Luton Electricity Committee has decided that, in consideration of the electrical engineer's administrative staff withdrawing their claim to take advantage of the 12½ per cent. increase of wages granted under the award of the Chief Industrial Commissioner, increases of salary be granted as follows, as from March 1st:—MR. H. A. KELL (chief assistant), from £240 to £265; MR. A. H. GATES (chief technical assistant), from £225 to £250; and MR. R. HARDING (chief clerk), from £175 to £200.

The Keighley Tramways Committee recommends that the salary of MR. HARRY WEBBER, the borough electrical engineer, as tramway manager, be increased from £100 to £175 per annum.

The proposal of the Blackburn Electricity Committee that £500 should be given out of war profits to MR WHEELWRIGHT, the borough electrical engineer, has been postponed.

Liverpool Tramways Committee recently decided to create the office of deputy manager. It has now recommended the appointment of MR. J. S. D. MOFFETT, general manager of the Belfast Corporation tramways, to that position.

MR. JOHN SCOTT, station superintendent at Accrington Corporation electricity works, was caught by a moving wagon at the works on March 20th, and had his hips badly crushed.

MR. H. R. FORBES MACKAY, electrical engineer of the Sydney Municipal Council, has returned to Australia after a short visit to Canada and the United States.—*Commonwealth Engineer.*

General.—MR. ARCHER SMITH, who for the past five years has been district manager of the Post Office telephones in the Belfast district, has been appointed to the district managership of telephones in the Newcastle-on-Tyne district.

Roll of Honour.—SAPPER GEO. MORLEY, R.E., killed in Italy by a bomb, was prior to the war in the electrical department of the post office at Carnforth.

PRIVATE C. P. COPSON, Leicestershire Regiment, engaged in the electric light department of the Midland Railway Co. at Leicester, is reported killed after being listed as wounded and missing.

PRIVATE J. SHELMERDINE, Ashton Territorials, who has been awarded the Military Medal, was employed at the Ashton-under-Lyne Corporation electricity works.

The death from wounds, while a prisoner of war, is announced of LANCE-CORPORAL H. J. KING, Worcestershire Regiment, formerly employed at the electrical accessories works of Messrs. Vickers, Birmingham.

CITY NOTES.

Newcastle-upon-Tyne Electric Supply Co., Ltd.

At the annual meeting, on March 21st, Mr. J. H. ARMSTRONG, the chairman, said that the capital expenditure for the year had been £202,647, mainly incurred at Carville and Dunston power stations. It was hoped that, by the end of the current year the whole of the extensions at Carville would be carried out, and, when that was done, that station would be complete, as they had no further room for extensions there, and the station would then have a capacity of 120,000 H.P. The alteration they had made in connection with the reserve and depreciation accounts had necessitated a change in setting out their profits, so that it had been impossible to give as clear a comparison of the figures with the year 1916 as might have been desired. On the same basis as the 1916 figures, the profit for the past year—before setting aside anything for depreciation or reserve—was £281,915, as compared with £224,266, an increase of £57,649. The amount available for dividend was £136,607, as against £108,889 in 1916, of which £64,325 was required for the preference dividend, an increase of £18,708 over 1916, owing to the increase of that class of share which was necessary to carry out the exchange with the Cleveland shareholders on the Newcastle Co. acquiring their interest in the Cleveland Co. The chairman then explained the change that had been made in regard to the reserve accounts. They had now acquired practically the whole of the shares in the Cleveland Co.—at present they held, he thought, 99 per cent. At their last meeting the belief was expressed that before many years the Tees district would hold a leading position in industrial enterprise on the North-East Coast, and it was also mentioned that the Cleveland Co. had received many applications for the supply of current, both from its existing customers and in connection with new manufacturing undertakings, which the Cleveland directors had not seen their way to meet, owing to the difficulty of financing. The expectations of the Newcastle board in connection with such developments had been realised somewhat more quickly than they anticipated, and he was pleased to state that the terms had been arranged for the supply of large quantities of electrical energy by their newly-associated company to new customers, who were now erecting works in the Tees area. In order to meet these orders for current it was necessary that further generating plant should be provided, and for this purpose a suitable site had been secured upon which a new generating station was in course of erection. The site was situate on the north side of the river Tees, with ample river frontage, good access to the North-Eastern Railway, and by road immediately behind it, and, furthermore, it was situate at a point where their interconnecter cables passed through from Durham into Yorkshire. The Tees Power Station Co., Ltd., had been formed under the auspices of the Newcastle Co., and inasmuch as the site selected for the erection of this new generating station was a considerable distance outside the Newcastle Co.'s area of supply, and partly for financial reasons, it was considered advisable that this new station should be erected and owned by a separate company. Of the £700,000, £200,000 of shares had been allotted to this company, and £50,000 had been paid up thereon, while £600,000 had been raised by the issue of 6 per cent. first mortgage debentures. The plant in this station would, in the first instance, consist of two turbo-alternators, having a total capacity of 53,000 H.P. Arrangements had been made under which the Newcastle Co. would lease and operate the station, and all energy produced therefrom would be sold and distributed by or through the Cleveland Co. The chairman said they would probably have seen the references in the Press in connection with the report of a Sub-Committee on Electric Power Supply, and the references made to the Newcastle companies. He spoke upon the development of that company from the time when it was supplying light to a portion of the city, and how it was developed into a power company. At that time they consulted Messrs. Merz and McLellan, whose scheme for supplying power through a large area was adopted by the directors. It was a complete scheme of development, which was practically the same as that in being to-day. This was not only the first comprehensive power scheme in the country, but the first of its kind in the world. The area now controlled by this company was some 1,400 miles. Throughout that area they were dealing with either the whole of the power supply, or had intimate working relationships with the local authorities, with the exception of Sunderland, South Shields, and Darlington. He should like to make it quite clear that they were ready to discuss inter-working arrangements whenever those authorities desired to do so, but no attempt would be made to extend their powers of general supply over their areas, or compel them to make working arrangements with that company. Referring to the Coal Conservation Committee's report, he said there was one matter to which he wished to refer. As a reply to the somewhat eulogistic remarks that were made by the Government Committee, and the general suggestion that that company's undertaking might be taken as an example of what was required to secure a cheap supply of current on a large scale, one of their shareholders had recently issued a pamphlet, one of the objects of which appeared to be to question the accuracy of the finding of the Government Committee as to the cheapness of the company's supply to their consumers. He thought they could be satisfied from the fact that that Committee was composed of electrical and other experts, that they not only knew exactly what information they required, but also that they admitted nothing as accurate until it had been proved to the hilt, and it was, he considered, a sufficient answer to that point to state that the average prices at which they supplied electricity to their customers (not by one associated company to the other) were lower than the average prices offered by any other undertaking. There was one point in which he was in entire agreement with this shareholder, viz., that it would be a great simplification if this company

and all its associated companies could be amalgamated into one, owning and operating everything through the entire area which they now controlled, but the present position was not of their seeking, and the only way in which that company could extend its area was as a holding company, by acquiring the interests of local and adjoining companies. Referring to the proposed increase of capital, the chairman said that the directors had come to no decision as to when, and to what extent, it might be advisable to make an issue of further capital, but in view of the largely increased demands which were being made upon them, &c., they thought it well to take the step in good time.

Dr. Merz seconded the adoption of the report.

Mr. A. Gemmell criticised certain items in the report, and said the chairman had not convinced him that the business was on a sound basis. He acknowledged having issued the pamphlet referred to, and said its reception in influential circles justified its publication.

The report was adopted.

An extraordinary meeting followed, at which an increase of capital was sanctioned to the extent of £790,000, 205,000 preference shares of £1 each, and 585,000 ordinary shares of £1, making the present authorised capital of the company £3,000,000.

British Aluminium Co., Ltd.—The financial result for 1917 was recorded in our last issue. The report states that the hydraulic works at Kinlochleven, for the provision of additional water supply to the Blackwater reservoir, were sufficiently completed to enable the water from Loch Eilde Mhor to be utilised as from the beginning of this year. The alumina works at Burntisland are now practically complete, and the manufacture of hydrate of alumina has been proceeding for some months. The output of aluminium has been used entirely for munition purposes, and the price of the metal has been fixed by the Government. The company is making application to Parliament during the present session for the necessary powers to develop a further large water power in Scotland, situate in the County of Inverness, in proximity to the Kinlochleven factory.

Clyde Valley Electrical Power Co.—Profit for 1917, £89,504, plus £25,797 brought forward. After paying net interest and preference dividend, putting £50,000 to contingency fund for depreciation, £7,587 to special reserve, and paying 2½ per cent. for the year, free of tax, on the ordinary shares, £21,146 is to be carried forward. The amount of excess profits' duty as adjusted to June, 1917, also provision for the estimated assessment for the December half-year, are included in the item "Rates and Taxes" in the revenue account. The extensions to Clyde's Mill power station have been completed, and the plant is in operation. A 15,000-kw. turbo-alternator is being added at Yoker power station. Mr. P. A. Lang has retired from the board, and Mr. J. W. Cloud has taken his place.

Yorkshire (West Riding) Electric Tramways Co., Ltd.—The report for 1917 shows a net income, after providing for debenture interest and making provision for deferred repairs, of £32,521; £15,952 was brought forward, making £48,474. Dividend 6 per cent., less tax, on preference shares; £5,000 to purchase of funded preferential dividend certificates; £12,456 is put to renewals, depreciation, and reserve fund; and £20,609 is carried forward.

Mackay Companies.—The report states that income from investments in other companies was $4,519,364, and dividends paid on the Mackay Companies shares $4,425,198. Operating and other expenses, including Federal income-tax, amounted to $89,058, the balance carried forward being $5,108.—*Financial Times.*

Sunderland District Electric Tramways, Ltd.—Interest at the rate of 3 per cent. per annum, less tax, is to be paid on the first income bonds, and £898 carried forward. There was an increase of £5,136 in traffic receipts during the year, but working expenses were considerably higher. The net result is an increase of £666 in profit.

Salisbury Electric Light & Supply Co., Ltd.—The profit for 1917, including £2,118 brought forward, was £7,831. Debenture interest absorbs £799, a dividend of 6 per cent. is paid for the year, £2,000 is put to depreciation and reserve, and £2,906 is carried forward.

Newmarket Electric Light Co., Ltd.—During 1917 the lamps connected (33-watt) were 1,012, making the total 32,937. Profit, including £483 brought forward, £2,503. Debenture interest £710, dividend 2½ per cent., £750 to reserve for plant renewal, carrying forward £379.

Hastings & District Electric Tramways Co., Ltd.—After paying 6 per cent. on the preference shares, £2,500 is carried to depreciation, £4,810 is put to reduction of suspense account, and £861 is to be carried forward.

W. T. Henley's Telegraph Works Co., Ltd.—Subject to audit, the directors recommend a final dividend on the ordinary shares of 10 per cent., less income-tax, making 15 per cent. for the year, and also a bonus of 10s. per share, less income-tax.

Waste Heat and Gas Electrical Generating Stations, Ltd.—During the year ended at January, 1918, the profits, after deducting administration expenses, were £40,731, against £40,060 in the previous year. £12,000 of this has been put to reserve. Including £19,411 brought forward the available profit is £48,142, as against £45,511. After transferring £5,000 to experimental expense account, and paying 8 per cent. dividend, £17,542 is to be carried forward. After considerable delay the whole of the new generating plant for the Weardale power station is on site, and undergoing preliminary trials. The plant will be more expensive than was anticipated, and the starting up involves expenditure of an experimental nature. Arrangements have been made for carrying out certain experimental work jointly with the Newcastle-upon-Tyne Electric Supply Co., Ltd., which it is hoped will further the company's interests. Progress has not yet been possible in connection with the proposed station at Horden, but the sanction to proceed has been received from the Ministry of Munitions, and contracts are being prepared. Constructional work will proceed as rapidly as conditions allow. The company's plant at Tees Bridge, the smallest of the company's power stations, had to be closed down last July owing to an alternator breakdown. It is now undergoing repair. Revenue from units generated by the company is 4 per cent. less than for the previous year.

Brompton & Kensington Electricity Supply Co., Ltd.—The credit balance for 1917, including the amount brought forward and interest received, was £35,700. After paying the preference interest, 10 per cent. on the ordinary shares, putting £10,000 to reserve, writing £337 off investments, and putting £1,000 to directors' additional remuneration, £5,217 is to be carried forward. The equivalent of 35-watt lamps connected increased by 38,095 to 383,839. Customers increased by 182 to 6,860. The gross receipts were £61,898, against £55,878 for 1916. The expenditure fell from £31,940 to £31,580. The net receipts advanced from £23,938 to £30,319. Average price per unit fell from 4.1d. to 4.05d. The dividend increased from 9 per cent to 10 per cent. Meeting: March 28th.

Tucuman Tramways, Light & Power Co.—According to a financial contemporary, the accounts, after payment of debenture interest, show a loss of £14,093, making a total debit balance of £49,304 to be carried forward.

Mirrlees Watson Co., Ltd.—Dividend, 12½ per cent.

STOCKS AND SHARES.

Monday Morning.

The great battle absorbs all other considerations. Stocks and shares are relegated to a background. There seems to be something anomalous, to put it mildly, in Stock Exchange affairs what time life and death struggle with such furiousness on the Western Front. Business in securities is therefore very quiet, and the quickening of demand for War Bonds is expected as a matter of course. This would tend to make gilt-edged stocks dull, and, in this connection, it may be mentioned that quotations for Home Railway prior-charge securities are going down steadily. Market opinion ascribes this to the "Tank" campaign and its after-effects.

Metropolitan Railway 3½ per cent. preference have recently weakened to 54¼, and the 5 per cent. preference to 74¼. London Electric 4 per cent. preference can be bought at a little under 60, giving a yield of £6 13s. 6d. per cent. on the money. The company's 4 per cent. debenture stock last changed hands at 66¼. District 4 per cent. prior lien debenture stands at 70. Underground Incomes—to drop into another class of security—are heavy at 79.

The Brompton & Kensington Electricity Supply Co. is another which did well last year. A final dividend at the rate of 12 per cent. makes 10 per cent. for the twelvemonth, as against 9 per cent. in the previous period. The reserve fund is raised to £55,000, and the directors take an additional remuneration of a thousand pounds. Brompton ordinary have risen to 6¼, and still yield a handsome return upon money invested in them. Westminsters continue to be a weak market at 6¾, and there appear a good many shares still on offer. When once these are taken, Westminsters can be almost counted upon to recover. Kensingtons are better at 5¼. No change of consequence has taken place in the City group.

The flatness of gas stocks, alluded to recently, has been stayed by the semi-official promises of concessions to the companies, these concessions being expected to take the form of some modification of the sliding scale applicable to the dividends permitted to be paid as governed by the price of gas.

The granting of an additional hour to theatres, whereby they can remain open until 10.30 p.m., is regarded in Stock Exchange quarters as on a par with many other actions of the Government.

Telegraph investments are noticeably good because of the imminence of the Budget, and the probabilities of further taxation. This gives a renewed fillip of popularity to companies paying dividends free of tax on their ordinary capital, although it has to be remembered that there is no guarantee of the continuance of the practice. Still, the leading cable

companies occupy positions of such commanding strength that they, at any rate, are not likely to make any departure from previous principles; hence the rises in Eastern Extensions, Westerns and Eastern Telegraphs. Globes keep very steady at 14¼. Marconis suffered from a little profit-snapping after their sharp rise on the result of the company's law-suit, and the price eased off to 3 7/16 sellers. American Marconis, on the other hand, present a better front at 25s. Oriental Telephone and United River Plates are both firmer, while Panama ordinary remain somewhat heavy.

W. T. Henley's Telegraph ordinary shares are to receive 10 per cent. dividend, making 15 per cent. for the year, plus a bonus of 10s. per share, bringing up the total to 25 per cent., the same as for 1916. The share distribution is, of course, the plum, and Henley's hold their rise at 19¼. General Electrics have advanced to the level £20, twice their nominal par value, and it is considered that although the company appears to be paying a high price for Fraser & Chalmers's Erith works, the bargain is likely to turn out favourably for the General Electric. A further spurt in Callender's to 18¼, another jump in India-Rubber shares to 16¾, a partial recovery of the dividend and bonus just deducted from the price of Telegraph Constructions, are illustrative of the strength in this department.

Electrical manufacturing shares continue quiet. Engineering issues are undecided. Babcocks are a trifle easier. Chemicals keep good, supported by rumours of a combination of interests. Castners rose to 3⅜. The rubber share recovery has made further upward progress. Speculation in tin mining descriptions ebbed away as the price of the metal reacted after its big rise.

SHARE LIST OF ELECTRICAL COMPANIES.

HOME ELECTRICITY COMPANIES.

	Dividend 1916.	Dividend 1917.	Price March 22, 1918.	Rise or fall this week.	Yield p.c.
Brompton Ordinary	9	10	69	+ ½	£7 8 0
Charing Cross Ordinary ..	5	5	3⅜	— ⅛	6 18 6
do. do. do 4½ Pref..	4½	4½	3⅜	—	6 18 6
Chelsea	3	3	3	—	5 4 4
City of London	8	8	12⅝	—	6 4 2
do. do. 6 per cent. Pref.	6	6	10⅛	—	5 18 6
County of London	7	7	11½	—	6 6 0
do. 6 per cent. Pref.	6	6	10⅛	—	5 18 5
Kensington Ordinary	8	7	8½	+ ½	6 8 0
London Electric	Nil	Nil	1⅛	—	Nil
do. do. 6 per cent. Pref.	4	5	3½	—	8 0 0
Metropolitan	3	4	3⅜xd	—	5 18 6
do. 4½ per cent Pref.	4½	4½	3⅝	—	6 13 4
St. James' and Pall Mall ..	8	9	7⅝	—	6 6 4
South London	5	5	2 ⅜xd	—	7 1 4
South Metropolitan Pref. ..	7	7	21/-	—	6 13 4
Westminster Ordinary	7	9	6⅜	— ⅛	7 0 6

TELEGRAPH AND TELEPHONES.

	Dividend 1915.	Dividend 1916.			
Anglo-Am. Tel. Pref.	9	9	9¼	—	6 7 0
do. Def.	23/8	1½	12⅜	—	6 13 4
Chile Telephone	8	8	7½	—	5 10 4
Cuba Sub. Ord.	6	7	9⅝	—	*7 11 4
Eastern Extension	8	8	15⅝	+ ¼	*5 4 0
Eastern Tel. Ord.	8	8	153⅛	+2	*5 4 6
Globe Tel. and T. Ord.	7	7	14½xd	—	*4 1s 3
do. Pref. ..	6	6	10	—	6 0 0
Great Northern Tel.	22	24	36	—	6 11 6
Indo-European	13	13	51½	—	6 6 8
Marconi	10	15	3 7/16	—	4 8 0
Oriental Telephone Ord. ..	10	10	4⅜	+ 1/16	2 7 1
United R. Plate Tel.	8	8	7⅛	—	*5 17 4
West India and Pan	6d.	6d.	1⅜	—	*3 17 0
Western Telegraph	7	8	15⅝	+ ¼	*5 2 8

HOME RAILS.

Central London, Ord. Assented	4	4	61½	—1	6 10 7
Metropolitan	1	1	29⅝	— ¼	4 15 8
do. District	Nil	Nil	14⅛	—	Nil
Underground Electric Ordinary	Nil	Nil	1⅜	—	Nil
do. do. "A" ..	Nil	Nil	5/-	—	Nil
do do Income	6	4	70	— ½	*5 1 6

FOREIGN TRAMS, &c

	Dividend 1915.	Dividend 1917.			
Adelaide Sup. 6 per cent. Pref.	6	6	4⅜	—	6 3 1
Anglo Arg. Trams. First Pref	5¼	5¼	2⅝	—	—
do. 2nd Pref. ..	5¼	—	2½	—	—
do. 5 Deb. ..	5	5	66½	—	7 10 6
Brazil Tractions	4	4	44⅛	—	—
Bombay Electric Pref.	6	6	94	—	6 6 4
British Columbia Elec. Ry. Ptfe.	5	5	53½	— ½	9 12 4
do. do. Preferred	Nil	Nil	32½	—1	Nil
do. do. Deferred	Nil	Nil	27⅛	— ½	Nil
do. do. Deb.	4½	4½	5⅝xd	—	7 6 7
Mexico Trams 5 per cent. Bonds	Nil	Nil	37	—	Nil
do. 6 per cent. Bonds	Nil	Nil	8½	—	Nil
Mexican Light Common ..	Nil	Nil	17⅝	—	Nil
do. Pref.	Nil	Nil	29	—	Nil
do. 1st Bonds ..	Nil	Nil	86½	—1½	—

MANUFACTURING COMPANIES

Babcock & Wilcox	15	15	3⅞	— 1/16	4 5 9
British Aluminium Ord. ..	7	10	1⅞	—	6 0 9
British Insulated Ord.	17½	20	8⅝	—	5 6 8
British Westinghouse Pref. ..	7½	7½	2⅜	—	5 2 0
Callenders	20	20	18¼	+ ½	5 9 9
do. 5 Pref.	5	5	4		6 5 9
Castner-Kellner	22	20	3⅜	+ 1/16	6 10 2
Edison Swan, fully paid	—	—	2½	—	Nil
do. do 4 per cent Deb	4	4	75½	—	5 6 0
Electric Construction	7½	7½	1½	—	6 0 0
Gen. Elec. Pref.	7	7	10⅜	—	5 15 8
do. Ord.	15	15	20	+ ½	6 0 0
Glenfield	12	12	144	—	6 8 2
do. 4½ Pref	4½	4½	82	—	5 12 2
India-Rubber	15	15	16¾	+ ½	*3 2 6
Telegraph Con.	20	20	49xd	+ ½	*5 18 0

*Dividends paid free of income-tax.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and they may vary according to quantities and other circumstances.

Monday, March 25th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Oxalic	per lb.	1/6	..
a Ammoniac Sal	per ton	£75	..
a Ammonia, Muriate (large crystal)	,,	£72	..
a Bisulphide of Carbon	,,	£23	..
a Borax	,,	£38	..
a Copper Sulphate	,,	£67 0/-	..
a Potash, Chlorate	per lb.	2/6	..
a ,, Perchlorate	,,	2/-	..
a Shellac	per cwt.	£31 10/-	..
a Sulphate of Magnesia	per ton	£16	..
a Sulphur, Sublimed Flowers ..	,,	£25	..
a ,, Lump	,,	£25	..
a Soda, Chlorate	per lb.	1/-	..
a ,, Crystals	per ton	17/-	..
a Sodium Bichromate, casks ..	per lb.	..	..
METALS, &c.			
c Brass (rolled metal 2' to 12' basis)	per lb.	..	..
c ,, Tubes (solid drawn) ..	,,	..	..
c ,, Wire, basis	,,	..	..
c Copper Tubes (solid drawn) ..	,,	1/7 to 1/7½	..
g ,, Bars (best selected) ..	per ton	£147	..
g ,, Sheet	,,	£147	..
g ,, Rod	,,	£147	..
d ,, (Electrolytic) Bars ..	,,	£125	..
d ,, ,, Sheets ..	,,	£152	..
d ,, ,, Wire Rods ..	,,	£133	..
d ,, ,, H.C. Wire	per lb.	1/5⅝	..
f Ebonite Rod	,,	3/-	..
f ,, Sheet	,,	2/6	..
n German Silver Wire	,,	2/3	..
h Gutta-percha, fine	,,	6/10	..
h India-rubber, Para fine	,,	9/10	2¼d. inc.
i Iron Pig (Cleveland warrants) ..	per ton	Nom.	..
l ,, Wire, galv. No. 8, P.O. qual.	,,	£42	..
g Lead, English Pig	,,	..	..
g Mercury	per bot.	Nom.	..
e Mica (in original cases) small ..	per lb.	6d. to 8/-	..
e ,, ,, ,, medium	,,	3/6 to 6/-	..
e ,, ,, ,, large ..	,,	7/6 to 14/- & up.	..
d Silicium Bronze Wire	per lb.	1/6½	..
r Steel, Magnet, in bars	per ton	..	..
g Tin, Block (English)	,,	..	..
n ,, Wire, Nos. 1 to 18	per lb.	4/2	..

Quotations supplied by—

a G. Boor & Co.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespeare.
h Edward Till & Co.
i Bolling & Lowe.
l Richard Johnson & Nephew, Ltd.
n P. Ormiston & Sons.
r W. F. Dennis & Co.

Electroplating Steel Springs.—One of the serious problems that confronts the makers and users of non-corrodible steel springs is the brittleness produced therein during electroplating, caused by the nascent or atomic hydrogen which is liberated at the cathode. The flexibility and elasticity of iron wire and steel springs are greatly decreased by pickling, and the effect is the more marked the thinner the material. Tin dipping before copper-plating is found to prevent embrittlement entirely. Steel springs may be dipped in molten tin at a temperature of 260° to 300° C. without appreciably changing their mechanical properties.—*Journal* of the Franklin Institute.

Coal in Algeria.—The recent discovery of beds of anthracite of considerable extent near Bona, in Algeria, has attracted the attention of the French Government, which has now taken over the working of the coal beds. The anthracite is stated to be equal to the best Cardiff coal, and can be sold at a price not higher than 150 lire a ton. Exported to Italy, its price would be about 210 lire per ton, and a first consignment of 30,000 tons will be ready to be shipped in two or three months. Many Italian thermal electric undertakings have been compelled to suspend working in consequence of inability to obtain imported coal, and the present opportunity is hailed with much satisfaction.

L.C.C. Tramway Requirements.—Owing to the difficulty experienced by many tramway undertakings in obtaining delivery of material from contractors, many of whom are bound to give preference to national work, tramway authorities frequently find it necessary to place emergency orders with firms with whom contracts have not been placed. The Board of Trade Tramways Committee has, therefore, proposed to the L.C.C. that it is necessary during present conditions that the practice of inviting tenders should be temporarily discontinued to enable orders for materials to be placed where delivery can best be made. After considering the matter, the L.C.C. Highways Committee proposes as an experiment until October 31st, 1918, that the practice of inviting tenders for six or twelve months' supply of tramway stores and equipment shall be discontinued, and that offers shall be obtained from time to time for the supply of goods, &c., required for the tramway department, subject to a limit of £250 in any one case.

NATIONAL ELECTRICITY SUPPLY.

By A POWER STATION ENGINEER.

If the most economical results are to be obtained in the future, generation must be on a larger scale than it has been in the past, which necessarily implies the use of larger units of plant situated in positions specially selected, so as to reduce to a minimum the transport of fuel, and in order to obtain a sufficient supply of natural water for condensing purposes. To better understand these two important points, it may be worth while to consider what quantities are likely to be required.

Assuming a power station supplying a maximum load of 100,000 KW., which will certainly be required and possibly exceeded in some industrial districts, and a load factor of 57 per cent., the output will amount to approximately 500,000,000 units per annum. Exception may be taken to so high a load factor, but there is no doubt whatever that by pooling the output of a number of smaller power stations, thus improving the diversity factor, such a figure is well within the range of practical politics. Several undertakings already show load factors exceeding 30 per cent., and in a certain important district in the country a figure well over 60 per cent. is obtained.

With individual plant units of 15,000/20,000 KW., and fuel of 11,000 to 12,000 B.TH.U., the consumption should not exceed, and, in fact, should be rather less than 2 lb. per E.H.T. unit delivered to feeders. On the output mentioned, the coal consumption will amount to 450,000 tons per annum—say, 8,600 tons per week, or at a maximum rate of 1,550 tons per day, Monday to Friday inclusive, and considerably less on Saturdays and Sundays. This is equal to 150 to 200 wagons per day, or 15 to 20 wagons per hour on a 10-hour day. There should be no great difficulty in handling this amount, provided the sidings and bunkers are properly designed for the purpose. A far bigger problem is involved in the disposal of the ashes, which may be from 1,200 to 1,500 tons per week, and in selecting the site special consideration must be given to this point. It is extraordinary how quickly the large open spaces, valleys, or tips become filled up when used as a deposit for refuse from stations even of moderate size, and it is clear that the regular dumping of some 1,500 tons a week will effect a considerable change in the contour of the land in the immediate surroundings of a large power station.

The quantity of condenser water required will be six to seven million gallons per hour. This represents a stream having a minimum summer flow of water equal to 60 ft. wide and 4 ft. deep, moving at the rate of one mile per hour. The districts in this kingdom where a river exists capable of affording water to this extent can be counted on the fingers of two hands. The only alternatives are tidal waters or cooling towers, unless considerable structural costs are incurred in providing large reservoir accommodation in connection with rivers or streams having a less flow in summer and a greater flow in winter. The first alternative will in some cases prove a solution to the problem, particularly in localities where it is cheaper and more convenient to transport fuel by boat instead of by rail; but in a number of industrial districts situated within a reasonable distance of coal fields, cooling towers will have to be adopted wholly or in part by reason of the fact that they will be less costly in construction and more economical in operation than the provision and use of transmission lines between such districts and positions where natural water is available.

It is unfortunate, but nevertheless a fact, that many of the most important industrial districts are situated either where water is plentiful and collieries at a distance, or where coal is adjacent while an ample supply of water is almost, if not entirely, absent. The case of London may be taken to illustrate the first type of district—the Thames would provide sufficient water, but the nearest collieries are situated in the Midlands or in Kent, not less than 50 miles away. Birmingham, Sheffield, and Manchester have collieries within a convenient radius, but it is often necessary for them to obtain supplies from more distant sources; water in large quantities is not less than 50 miles distant. Apart altogether from what may be termed the economic question—*i.e.*, whether it will be cheaper to transport fuel into industrial centres or to transmit electrical energy to such centres from colliery districts—there is the larger question whether a large industrial community whose demand may reach and even exceed 500,000 KW. should be entirely dependent on long transmission lines for its daily transport, employment, and domestic requirements. I cannot conceive that a large City Council responsible for the supply of so important a commodity would be content to depend wholly on a distant power station.

Many of those who have read the Coal Conservation report have the impression that the Committee advocates the establishment of 16 super-stations to supply the whole of the country. This interpretation is clearly wrong. Taking the total demand as 10,000,000 H.P. for all purposes, this reading of the report would necessitate the setting-up of individual power stations dealing with a demand approaching 1,000,000 H.P., or, say, 750,000 KW., in certain dense industrial districts. Such a proposal would be entirely impracticable, considered from the coaling and condensation-water point of view. The intention as expressed is to divide the country into 16 districts for administration purposes, and each district authority, knowing the needs and the localities where power is required, will determine how many power stations are necessary and where they can be placed to the greatest advantage. In some cases it may be possible to supply the whole of a district from one power station, while in others five to ten may be wanted.

It will be of interest to consider what form of Central Government Authority should be set up by Parliament to exercise administrative powers in connection with the reorganisation of electricity supply on a national basis. An alteration in present methods is long overdue. The Board of Trade has far too many duties to perform, and should be relieved of its responsibilities in this matter. The capital expenditure at the present time on electricity supply undertakings is approximately £120,000,000, and the income derivable therefrom exceeds £20,000,000 per annum. Developments in the near future must inevitably lead to an increase in the expenditure to at least £500,000,000, from which an income of £100,000,000 may be expected.

The amount of capital involved, and the vital necessity of exercising economy in the use of fuel, so as to provide the cheapest possible supply of power for the benefit of industries, are surely of sufficient importance to justify the setting-up of a special Government Department to deal solely with such questions.

Irrespective of the form of authority which may hereafter be formed to exercise powers in each of the 16 districts, it is necessary that such a Department should be established to which would be transferred the duties in regard to electricity supply matters now exercised by the Board of Trade, the Local Government Board, and, to a less extent, the Home Office.

The State Department would probably have at its head a political Minister, not necessarily possessing any special technical or engineering qualifications, who would be responsible to Parliament. A permanent secretary would hold the chief executive office. As advisers there would be appointed several departmental heads consisting of experts on such matters as land and buildings, mechanical and electrical engineering, technical investigation, electric lighting legislation, and finance. They would, in fact, occupy much the same position as the Commissioners who have been advocated by various supply interests. The heads of the Departments would be paid such a salary as would attract really first-class men, and they would be absolutely debarred from being interested, or in any way associated, with industries allied to electrical manufacturing or supply. On this Department will depend the successful development of electricity undertakings and the satisfactory establishment of the manufacturing and allied trades whose progress is so intimately concerned in an increased use of electrical energy.

(To be continued.)

THE CONTROL OF LARGE AMOUNTS OF POWER.

By E. B. WEDMORE, M.I.E.E.

(*Abstract of paper read before the* Institution of Electrical Engineers.)

(*Concluded from page* 286.)

APPENDICES.

Rupturing Capacity of Oil Switches.

Switches for any particular system must be rated to give satisfactory operation (1) under the severest emergency conditions, and (2) under normal service conditions. This requires the following:—

(*a*) They must break with certainty the maximum possible short-circuit they may be subjected to.

(*b*) The damage to the switch should be such as not to interfere with the commercial operation of the plant.

The second condition is the one which requires watching. For the usual conditions of electrical distribution it is quite sufficient if the switch will break the maximum short-circuit current twice, and after this be capable of carrying normal current.

For railway service and other heavy power service, where heavy short-circuits may be frequently met with, the switch will require to withstand the corresponding frequently-repeated shocks and destructive arcing, and must be rated accordingly.

Switches are obtainable able to cope with the severest conditions likely to be met with in this country for some time to come, and with a long record of good service behind them, giving the only possible non-speculative guarantee of their reliability under all manner of working conditions.

Switches have been employed in this country for many years past having great mechanical strength, chambers able to resist high explosive forces, high speed of break, and suitable contact design. These and other features all serve to give high rupturing capacity.

The designer's data are still largely empirical, and there are many ideas in circulation in the nature of half truths, such, for example, as that switches should be compared by comparing the length of break.

The above features in design are being incorporated in an increasing degree in switches of small size, with the intention of increasing the rupturing capacity without increase of dimensions and without much increase of cost. There has been no radical departure in the design of oil switches in recent years, and, until we have some important discovery to help us, switches will remain pretty much as they are now. Rupturing capacity and cost of switchgear equipments vary roughly in simple proportion.

A switch may be suitably rated for 1,000 amperes and 6,000 volts, and yet may be quite unsuitable for use on a 500-volt circuit where it is called upon to make circuit on several hundred amperes several times a day.

Switches for industrial use, if well designed, have a rupturing capacity of 5,000 to 15,000 K.V.A. Switches for consumers' premises and sub-stations will rupture about 10,000 to 35,000 K.V.A., according to size. Next there are lines of switches rated in the neighbourhood of 100,000 to 200,000 K.V.A., suitable for stations up to 30,000 K.V.A., and for large sub-stations on much larger plants.

Rating of Reactances.

In discussing the use and characteristics of reactances it is most convenient to rate them in terms of the percentage reactive voltage drop they will give on the full-load rating on the part of the plant with which they are associated.

In the case of bus-bar reactances, each reactance is associated with a section of the bus-bar, and should be rated on the total generator capacity attached to the section.

A feeder reactance may be rated at 3 per cent. when associated with the feeder, but if its effect on short-circuit is considered in connection with a generating plant of 10 times the feeder rating, it at once becomes 30 per cent. When rated in this way it may be added to the reactance of the generators expressed in the same terms. This method of rating enables the employment of reactances to be discussed in general terms and without reference to the size and voltage of the plant.

The individual reactance is best rated in amperes, carrying capacity, and ohms reactance at a given frequency, with the addition of working voltage, which determines the insulation required.

Arrangement of Bus-bars.

In the provision of bus-bars and switches, something more is required than a simple straight bus-bar, or even a single ring bus-bar with one switch per circuit. Additions are made both to give duplication for safety and to provide flexibility.

The first essential is a spare bus-bar arranged so that any section can be shut down without interfering with supply. In the matter of switches it is recommended that all normal switching operations should be done by means of oil switches, and that air-break switches should be used only for isolating parts already made dead by oil switches. By this course adequate duplication is provided, and the risk of serious trouble due to operator's mistakes in routine work is reduced to a minimum.

If oil switches are not duplicated, the fact of an oil switch being put out of commission for any reason prevents the corresponding machine or feeder being employed, and thus must lead in the long run to greater expenditure on spare plant or a greater risk of serious lack of spares on emergency.

Bus-bar reactances may be employed in either of two ways, conveniently described as the star and ring designs.

In the star design the bus-bar reactances are paralleled by tying them to a common point or tie bus-bar, whilst in the ring design each bus-bar section is tied to the next through a reactance (fig. 4).

With the star arrangement, whatever sections are employed are paralleled by the simple operation of coupling them to the tie bus-bar, whereas in the ring arrangement it is not possible to maintain the ring formation when one section is shut down, or easy to follow the load-transfer conditions, and mistakes are more easily made.

In many situations it is easier to make a good design with two bus-bars than with three, so that there is a use for the ring arrangement. The ring arrangement, however, has the defect that under working conditions the ring cannot always be maintained closed. The balance of advantage lies with the star design.

Current-limiting by the Use of Bus-bar Reactance.

Using the short-circuit current obtainable without bus-bar reactance as a unit, figs. 6 and 8 show the reduction obtained with different values of bus-bar reactance "B" expressed in terms of the generator reactance "A" and for different numbers of bus-bar sections. In fig. 6 from the bottom of the diagram it is evident that the introduction of a small amount of bus-bar reactance has a big effect in reducing the short-circuit values. As the reactance value is increased its effectiveness by no means increases proportionally. The same is true of increasing the number of sections.

The results are shown in a different form in fig. 8, the horizontal ordinates in which are the inverse of those in fig. 6

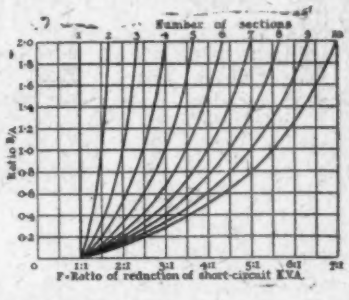

Fig. 8.—Reduction of Short-circuit K.V.A. with Star Design.

These curves cover the ground of what is practicable. The amount of bus-bar reactance permissible is limited by the permissible voltage difference between bus-bar sections, and in the endeavour to keep down short-circuit stresses the increase of generator reactance will keep down the ratio well within the range of the above curves and within economical limits.

So long as the generator reactance can be provided internally the cheapest combination will be that with minimum bus-bar reactance, but even if all necessary protection of plant could be obtained with generator reactance alone, it would still pay to employ bus-bar reactance owing to the protection afforded to continuity of supply.

Design of Current-limiting Reactances.

The special feature of reactances employed for current-limiting is that the current they have to limit on emergency is many times the maximum current they may have to carry continuously.

There is no gain in the use of iron in the design, as in order to ensure the correct reactance under heavy currents the iron has to be worked at very low densities under normal running. There are other good reasons for avoiding its use. There are great and obvious advantages in employing a design in which all parts are fully open to inspection, and this is impossible where iron is employed.

Fig. 9 illustrates a reactance designed for this class of service, and shows how readily all parts can be inspected. The coils are of bare copper, so there is no insulating material to give trouble. The only high-tension insulators are the very substantial ones forming the feet on which the reactance stands.

A reactance of this kind installed in a brick chamber cannot break down to earth, as there is no good earth in the neighbourhood.

Heating and Stresses due to Heavy Currents.

With adjacent conductors at 12-in. centres carrying current in opposite directions, the maximum repulsive force between

them will be 9 lb. per foot run for 10,000 amperes, R.M.S. value. The force varies inversely as the distance and proportionally to the square of the current, and often attains serious proportions in modern practice.

In a three-phase cable carrying 100,000 amperes on a fault the force may reach a maximum of 12,000 lb. per foot run, and would approach this in the joint boxes. Conductors spaced 1 ft. apart will be subjected to 900 lb. per foot run on the same current. Current transformers should not be subjected to more than 200 times normal load current.

A 300-ampere isolating switch of the type shown in fig. 10, or an oil switch of the type shown in fig. 11, with insulators at 10-in. centres, may have a force of 100 lb. distributed over the blade on a current of 20,000 amperes, or 600 lb. for 50,000 amperes. If the switch be designed as in fig. 12, the conductors will be almost in line with the blade, and the force due to the loop formation will be relatively negligible.

It is good practice to lock or latch the blades of all back-connected isolating switches on 6,000-volt plants where the output may reach 10,000 K.V.A. or upwards, and to latch all switches where the output may exceed 20,000 K.V.A. These figures are typical of what is required.

In conductors for alternating-current circuits above 2,000 amperes capacity "skin effect" has to be seriously considered. So long as the total thickness of the copper in the several laminations added together does not exceed 1¼ in., skin effect does not become serious, but above this figure it rapidly becomes a most important factor.

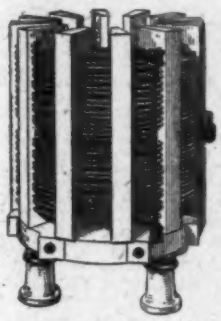

Fig. 9.—Current-limiting Reactance.

A copper bus-bar 10 ft. long and 2 sq. in. cross-section, able to carry, say, 2,000 amperes, will exert a theoretical maximum pressure of about 15 tons for a total temperature change, due to electric heating and atmospheric conditions, of 60 deg. C. The same bar for the same temperature change will increase in length by about ¾ in. This can be absorbed by deflecting the bar about an inch at the centre if it is free to move, or by the slipping of the bar on its supports. Expansion is generally taken care of by slipping. It is, however, good practice on long bus-bars to limit this by the use of expansion joints.

If heat is generated in a conductor very rapidly there is no time for radiation, convection, and conduction to play their part. Currents flowing in copper conductors at 1,000 amperes per square inch will raise the temperature 50 deg. C. per hour if the heat is all absorbed. On this basis a current of 100,000 amperes, say, 1,000,000 K.V.A. on 6,000 volts, will raise

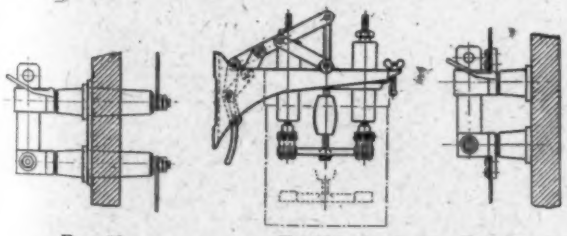

Fig. 10. Fig. 11. Fig. 12.

Fig. 10.—Typical Isolating Switch Subject to Large Forces.
Fig. 11.—Typical Oil Switch.
Fig. 12.—Typical Isolating Switch Subject to Small Forces.

the temperature of a 0.1 sq. in. cable at the initial rate of about 12,500 deg. C. per second.

The effect of the initial rise is to raise the resistance of the copper conductors, the specific heat remaining steady so that the rate of rise is accelerated as it proceeds.

The serious overheating of a conductor in a cable may damage the cable from end to end.

Experience with stations designed in recent years, and having a maximum short-circuit current of 10 times their normal rated output, has shown that it is necessary that the smallest current transformer on the main switchboard should have a carrying capacity not less than one-twentieth the station output. Current transformers of good design and much smaller than this have been exploded by the heat generated on a short-circuit.

THE NEW IRONCLAD-SWITCH DEPARTMENT AT WITTON.

In the report of the Coal Conservation Sub-Committee of the Reconstruction Committee it is stated that 95 per cent. of the factories erected for war purposes since August, 1914, use

Fig. 1.—Portion of the New Ironclad Switch Machine Shop at the Witton Works of the General Electric Co., Ltd.

electric power. This fact is an index to the enormous demand which the war has created for electrical plant and accessories. No limit was placed on the output demanded from manufacturers of generators, motors, switchgear, transformers, and every other class of standard product. In the case of the switch department at Witton, the space available

Fig. 2.—Fitting Shop, showing—on the right—the Transporter Tables by means of which the Assembled Switches are conveyed to the Test Panel.

soon became congested by the continuously increasing pressure of orders. At the beginning of 1916 it became apparent that the capacity of the department would need to be at least doubled if the output were to be maintained within reasonable distance of the most urgent demands. Various

plans for extensions were considered, but they had to be put aside owing to the lack of materials and labour for building operations. Eventually it was decided to make use of space which had become available in the central stores, as a result of stock reductions caused by abnormal war conditions. One-half of the top floor of the building was cleared and fitted up for the manufacture of ironclad switchgear. In spite of inevitable delay in securing the delivery of tools, the new shop proved capable, within a few months, of achieving the 100 per cent. increase in output for which it had been designed. A still further increase has since been attained.

The total space occupied by the ironclad switchgear shop is close on 7,900 sq. ft. More than half of the space is absorbed by the machine shop (1,645 sq. ft.), the fitting shop (2,280 sq. ft.), and the machined castings stores (1,095 sq. ft.), and the remainder is divided up between the assembly room (710 sq. ft.), the component stores (839 sq. ft.), the rough castings stores (826 sq. ft.), and the final inspection and paint-drying section (480 sq. ft.).

The whole of the machine shop is devoted to the special machining—and the special machining only—of ironclad switches. Various parts which are in general use for electrical work—such as standard bobbin fuse-holders, contact clips, and so on—are made in the general works. All the machinery is driven by "Witton" motors, the group system having been adopted as most economical for banks of similar machine tools operating continuously.

In the fitting shop, which is a wide bay arranged with transverse benches, the switches are put together ready for

FIG. 3.—Portion of the Assembly Shop for Ironclad Switches at Witton. The High-voltage Test Panel and the Paint-spray Turntable are visible in the centre, and the Stores in the background.

testing and painting. When the switches are completed they are placed on transporter tables, and carried by means of under-trucks to the test panel. After being tested at high voltage they pass on to a turntable in front of the compressed-air paint spray, which gives them an even coat of paint with an excellent finish in a much shorter time than is possible with a hand-brush. The switches then move to an open space for drying purposes, and finally to the packing department. Thus, from the time they are fitted up and put on the transporting table, they are never lifted. This arrangement is not only of the greatest value in securing rapidity of production, but it is practically essential in view of the fact that all of the work is done at present by women, who would find great difficulty in lifting the switches.

The transporter arrangement is as simple as it is effective. It consists of a truck and a number of wooden platforms. The truck has two frames, a lower and an upper one, which can be altered in height by means of a lever. Close to each machine or bench is placed a platform, on which the goods are loaded as they are finished. When the load is complete, the truck is brought under the platform, and the upper frame raised so as to lift the platform clear of the ground. The load is then wheeled away, and another platform placed in position for loading up.

The assembling shop and the stores are also laid out with a direct view to facilitating a large and speedy output. Squares are marked out on the floor of the assembly shop, so that the various parts can be conveniently arranged in groups before being taken to the fitting shop. The stores are constructed with four large double racks of bins, and each size of switch is allocated to a pre-arranged portion of the bins. At the end of the larger racks there are smaller ones for the reception of the smaller parts, each size being stocked separately. This subdivision, and the close proximity of the stores to both the assembly room and the fitting shop—all departments being on the same floor—reduce delays to a minimum, and enable the various steps in the process of construction to be co-ordinated with ease and efficiency.

NEW PATENTS APPLIED FOR, 1918.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by MESSRS. W. P. THOMPSON & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford

4,215. "Searchlights." H. MUNRO. March 11th.
4,275. "Electric condensers." W. DUBILIER. March 11th. (U.S.A., January 16th.)
4,329. "Receiving apparatus for wireless telegraphy." E. R. CLARKE. March 12th.
4,333. "Inductively untappable telegraph." A. H. MORSE. March 12th.
4,334. "Holders for electrodes of electric furnaces." J. R. HOULE. March 12th.
4,336/7. "Electric contact-making and breaking apparatus." BRITISH THOMSON-HOUSTON CO. & A. P. YOUNG. March 12th.
4,353. "High-tension fuse." A. NIELSEN. March 12th. (Norway, April 12th, 1917.)
4,366. "Magnetos." G. A. CHAILLEY. March 12th. (France, December 29th, 1917.)
4,373. "Coin-collecting means for telephone systems." F. W. HALL. March 12th.
4,374. "Dies for shaping insulators, &c." H. O. BUSCH-JENSEN. March 12th.
4,397. "Apparatus for demonstrating systems of electric wiring." D. ROWAN. March 13th.
4,404. "Electric generators." H. SHAW. March 13th.
4,419. "Electric switches." SIEMENS SCHUCKERTWERKE. March 13th. (Germany, January 20th, 1917.)
4,428. "Control of electric furnaces." W. J. HOWARD. March 13th.
4,460. "Ignition system for internal-combustion motors." H. ROYER. March 13th. (France, January 16th, 1917.)
4,488. "Housing adjusting and locking nut for electric motor horn." J. W. MONK. March 13th.
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4,553. "Controllers for alternating-current motors." IGRANIC ELECTRIC CO. (Cutler-Hammer Manufacturing Co., U.S.A.) March 14th.
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4,640. "Electric motor controllers." IGRANIC ELECTRIC CO. (Cutler-Hammer Manufacturing Co., U.S.A.) March 15th.
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4,659. "Manufacture of bowls or shades for electric lights." J. W. BARNETT. March 16th.
4,680. "Ignition systems for internal-combustion engines." C. F. KETTERING. March 16th. (U.S.A., August 30th, 1915.)
4,689. "Electric cells or batteries." E. BAUR & W. D. TREADWELL. March 16th.

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The numbers underlined are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

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2,398. MANUFACTURE OF MULTI-CELL ELECTRIC BATTERIES. A. V. St. Armande. February 17th, 1917. (113,469.)
2,488. ELECTRIC MOTOR-CONTROL SYSTEMS. British Thomson-Houston Co. (General Electric Co., U.S.A.) February 20th, 1917. (113,473.)
2,570. AUTOMATIC CONTROL OF ELECTRIC GENERATING SETS FOR EMERGENCY OR STAND-BY PURPOSES FOR SHIPS, PUBLIC BUILDINGS, AND FOR OTHER PURPOSES. G. C. Pillinger & L. Sunderland. February 21st, 1917. (113,479.)
2,574. MOUNTING OF THE CAMS OF INTERRUPTORS FOR USE IN THE IGNITION OF INTERNAL-COMBUSTION ENGINES. H. de la Valette. February 23th, 1916. (104,870.)
2,600. MEANS FOR RENDERING LIQUIDS RADIO-ACTIVE. O. A. Elias. February 22nd, 1917. (113,483.)
2,691. CONTROLLERS FOR ELECTRIC CIRCUITS. British Thomson-Houston Co. (General Electric Co., U.S.A.) February 23rd, 1917. (113,332.)
2,895. IGNITION SYSTEMS FOR INTERNAL-COMBUSTION ENGINES. Philips Brinton Co. March 23rd, 1916. (105,327.)
2,991. SPARK PLUGS. A. L. Riggs. February 28th, 1917. (113,495.)
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3,285. ELECTROCHEMICAL PROCESS FOR THE TREATMENT OF METALLIC ORES. C. O. Griffith. March 6th, 1917. (113,508.)
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3,610. ELECTRIC SWITCH BOXES. W. T. Henley's Telegraph Works Co. and E. Moor. March 12th, 1917. (113,360.)
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